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Improving Scientific Literacy and Creativity through Project Based Learning

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Abstract

This research aims are to investigate the assesment of implementation of Project Based Learning in the material of Dynamic Fluid, to compare the value of scientific literacy and creativity between props group and poster group, and to analyze the relationship of scientific literacy and creativity of students. The research design used Mixed Method of Sequential Explanatory types. The sample is students of class XI-IPA SMA Muhamadiyah 3 Kayen, 25 students of the school year 2016/2017. The project in one class was divided into two, i.e. preparing props of principle and Bernoulli law, and preparing poster of principle and Bernoulli law. Students with props project was more active in scientific literacy activities and creative than student with the poster project. Based on the classical exhaustiveness test, the implementation of Project Based Learning with props project and the poster project has not been effective to improve the scientific literacy but it is effectively used to improve the creativity. The correlation test results show that there is no significant correlation between scientific literacy and creativity. Sustainable learning by making scientific approaches using scientific methods is needed to improve scientific literacy skills.

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INTRODUCTION

The 21st century demands an initiative of human resources, critical thinking, creative, competitive and capable of solving problems, in order to be able to compete globally. Science education is one of the important foundations in establishing quality human resources (Rusilowati *et al*., 2016; Gao *et al.,*2016; Nuri *et al,* 2018).

Indonesian result of *Trends in International Mathematics and Science Study* (TIMSS) 2011 shows a value of 397 with the value of the international average of 500 (Martin *et al.,* 2012). The results of the scientific literacy *Program for International Student Assessment* (PISA) 2015 shows that Indonesia rank was 62 out of 70 countries (OECD, 2016).

The result of the initial observation on the physics learning process conducted in XI-IPA class of SMA Muhammadiyah 3 Kayen showed that the teacher has used the experiment method and worksheet when teaching the material of Static Fluid. Experiment activities was continued by discussion and reporting, then presentation at the next meeting. The worksheet from teacher provides the work steps so that students can follow the step guidance without designing and developing new ideas in experiment activities. Classroom activiy showed that teachers use a variety of inquiry learning approaches without a comprehensive understanding of their use (Wenning, 2010).

Student's experiment reports show that aspect of scientific literacy which consists of science as a body of knowledge, a way of thinking, and way of investigating has not been achieved properly. This is evidenced by some student mistakes in answering some questions in the worksheet. Students had less literature studies and less understanding about the basic concepts taught by the teacher, so that students sid not a capability in preparing a good discussion of lab work according to the existing theories of physics.

According to Rusilowati *et al.* (2016), factors causing low students' mastery in the science as a way of investigating are: (1) students rarely do experiment activities; (2) students was not understand the terms in some scientific investigation activities such as independent variables and dependent variables; (3) students spend more time studying science with rote method. Science should give more student activity, reduce rote knowledge, more emphasis on science process skills to get the concept, and the more time students spend in the laboratory.

The initial test of scientific literacy skills and creativity given in XI-IPA class SMA Muhammadiyah 3 Kayen was about the Static Fluid Material. The test results showed that the classical completeness of scientific literacy ability equal to 36.36% and creativity classical completeness equal to 13.64%. This shows that the ability of scientific literacy and creativity was still low.

Scientific literacy and creative thinking should be habit as well as learning on Dynamic Fluid Material. Sabariasih *et al*. (2015) states that the difficult material is the Bernoulli Equation because many formulas that must be memorized and understood. One of the suitable models for the material is *Project Based Learning* (PjBL). Munawaroh *et al*. (2012) show that students' thinking ability with PjBL model was higher than the cooperative learning model in building the four pillars of learning. Research needs to be done to investigate the assesment of implementation of Project Based Learning in the material of Dynamic Fluid, to compare the value of scientific literacy and creativity between props group and poster group, and to analyze the relationship of scientific literacy and creativity of students Based on the above description it is necessary to conduct research on the improvement of scientific literacy ability and creativity of students through *Project Based Learning*.

METHOD

The research was conducted at SMA Muhammadiyah 3 Kayen, Pati Regency, Central Java Province. SMA Muhammadiyah 3 Kayen has one class XI-IPA consisting of 25 students. The sample technique used is saturated sampling, all members of the population are used as samples. Since the population is relatively small and less than 30 people (Sugiyono, 2009: 124) .

The PjBL model is assigned to the XI IPA class by dividing a class into two groups, a group prepare props of principle and Bernoulli law, and another group prepare poster design of principle and Bernoulli law. Each group consists of four groups with each group consists of 3 to 4 students.

Student project activities are conducted outside of school hours to streamline school learning activities. Students made a video of all the stage of the project task, so the teacher can observe the project implementation of the video made by the students. The project's task of preparing props and project tasks of preparing poster use material waste, so they do not spend much budget. This method is used to overcome the weaknesses of the model PjBL disclosed by Titu (2015), requires considerable time in learning activities, many equipment to be provided, costly, and many instructors feel comfortable with the traditional classroom, where the instructor holds a major role in the class.

Observation data, project values and questionnaires were analyzed to compare the implementation of PjBL on project tasks of props and poster in improving scientific literacy ability and creativity of students. Pretest and postest score of scientific literacy ability and creativity on Dynamic Fluid Material was analyzed quantitatively using comparative test of classical test (U test), and *spearman rank* correlation test. Interviews were then conducted to the students to deepen the research data.

RESULT AND DISCUSSION

The implementation of the PjBL Model

The result of observation data of PjBL model implementation in five meetings can be seen in Table 1.

Table 1. Result of Observation Data of PjBL Model Implementation

Implementation	(%)	Criteria
Project Based Learning (PjBL)	100%	All activities are done
Scientific literacy of Student	100%	All activities are done
Student Creativity	100%	All activities are done

The results showed that the stages of PjBL model can lead the students to do scientific literacy activities and creativity. The result of observation data analysis of students' scientific literacy activity and creativity on project task of preparing props and preparing of poster can be seen in Table 2.

Table 2. Observation Results Literacy Activities Science and Student Creativity

Aspect	Project	Percentage
Scientific literacy	Props	69.37%
	Poster	68.30%
Creativity	Props	72.65%
	Poster	72.45%

PjBL with project's task of preparing props leads students to be more active in scientific literacy activities and creative than PjBL with the project task of preparing a poster design. The preparing of props make student understand the real concept and support the success of learning. The results of

research are agreed by Arsyad (2009) and Widiyatmoko & Pamelasari (2012) which shows that props is a means of communication and interaction between teachers and students in the learning process that can explain the real concept. The results are agreed by Blumenfeld *et al.* (2009) that preparing props is used to assess the success of learning as measured by the level of learning experience acquired by students and depending on their treatment in learning, whether teacher treatment or student activity while studying . The results of data analysis of project assessment tasks of making props and project tasks of making a poster can be seen in Table 3.

Table 3. Result of Assessment of Props and Poster Project

Project	Percentage
Props	85.00%
Poster	80.68%

The results showed that the project of the props is better than the project of poster. Preparing poster does not involve experiment activities, only using case studies/literature studies of several references. The results of interviews with 3 people from 3 groups of posters still found difficulties to understand Bernoulli's principles and laws because the task of the poster tends to involve the process of thinking and imaging in applying Bernoulli principles and the principle of continuity. The design of props made in the form of posters was gotten by downloading from the internet. Furthermore one of four groups of posters that can modify the shape of the tool design.

Student response questionnaires on the PjBL model were analyzed using descriptive percentage analysis. Results of student questionnaire can be seen in Table 4.

Table 4. Results of Student Questionnaire

Project	Percentage	Category
Props	77.23%	Medium
Poster	78.67%	Medium

Based on the questionnaire analysis of student responses to the implementation of the PjBL model, the project task of the poster is preferred compared to the project proponent tasks. This is agreed by interviewing to the students i.e. although the project tasks of the props more interesting, the students prefer the project task of preparing a poster, because preparing poster was easier to solve than the task of preparing props.

The PjBL model implementation in five meetings in SMA Muhammadiyah 3 Kayen with student intake is low, unable to increase significantly the ability of scientific literacy. Different place, background, knowledge and environment also influence their scientific literacy competence (Ridwan *et al*., 2013).

Comparison of Scientific Literacy Ability between Props Group and Poster Group after PjBL Model Implementation

The ability of scientific literacy can be defined individual to identify the facts of science, using appropriate methods of inquiry to obtain the necessary scientific evidence and the ability to analyze and interpret the evidence therefore a meaningful conclusion can be reached (Rizkita *et al.*, 2016; Gormally, 2012).

The effectiveness of applying PjBL model to improve scientific literacy ability is analyzed based on classical completeness of postest value of scientific literacy The result of classical completeness of scientific literacy in two groups can be seen in Table 5.

Table 5. Result of Classical Completeness of Scientific Literacy

Project	Completeness	Information
Props	38.46 %	Not Complete
Poster	25.00 %	Not Complete

The results showed that the PjBL model with the project task of preparing props and poster can improve the students' scientific literacy ability, but still needed improvement in its implementation.

Improvement of pretest and postest values of scientific literacy aspects after using the PjBL model from project props and poster can be seen in Table 6. The change in pretest and postest values of every aspect of student scientific literacy consists of : (A) science as a body of knowledge, (B) science as a way of thinking, (c) science as a way to investigate, and (D) interaction between science, technology, society and the environment.

Table 6. Improvement of Pretest and Postest Values of Scientific Literacy

Aspects of Scientific literacy	Props Group			Poster Group		
	S_{pre}	S_{post}	Change	S_{pre}	S_{post}	Change
A	30.77	55.13	24.36	25.00	58.33	33.33
B	39.74	64.10	24.36	37.50	58.33	20.83
C	32.05	67.95	35.90	29.17	62.50	33.33
D	35.90	92.31	56.41	27.78	86.11	58.33

Increased pretest and postes of scientific literacy show that the PjBL model can improve students' literacy skills, both on the project task of preparing props and posters. This is agreed by Sari *et al.* (2017) and McCright (2012) demonstrating that students' literacy skills can be improved through the application of project-based inquiry learning.

Table 6. shows that projects props and posters can help students learn independently and conduct investigations from various references. This is agreed by Tseng, *et al.* (2013) and Jagantara, *et al.* (2014) stating that project-based learning is one type of learning that organizes students to build their knowledge independently through investigations and discussions to solve problems to achieve the planned targets.

U test is used to find out the comparison of scientific literacy ability between props and poster groups after PjBL model implementation. U test is used to test the comparative hypothesis of two independent samples when the data is ordinal and non parametric (Sugiyono,2015). The U test results are shown in Table 7.

Table 7. U Test Result of Scientific Literacy Aspects

U_1	U_2	U_{table}	Information
143	151	35	Ho accepted

From Tabel 7. a smaller U will be used for comparison with U table. n_1 is sample of props groups and n_2 is sample of poster groups. For n_1 is 13 and n_2 is 12 obtained U_{table} is 35. Ho in U test of scientific literacy i.e., there is no difference in scientific literacy ability between props group and poster group. U test result of scientific literacy aspect show that U_{count} more than U_{table}, so Ho is accepted.

Comparison of Creativity between Props Group and Poster Group after PjBL Model Implementation

The effectiveness of applying PjBL model to improve students' creativity is analyzed based on the classical completeness of postest value of creativity aspect. The result of classical completeness of creativity aspects in two groups can be seen in Table 8.

Table 8. Result of Classical Completeness of Creativity

Project	Completeness	Information
Props	92.31 %	Completed
Poster	83.33 %	Completed

Classical completeness test show that PjBL model effective used to improve students' creativity, both the project task of preparing props and poster.

Improvement of pretest and postest values of students' creativity aspects after using the PjBL model from two groups of project props and poster can be seen in Table 9. Improvement of pretest and postest values of each aspect of student creativity consists of: (A) fast answer, (B) fast respon, (C) flexibility, (D) authenticity, (E) details, (F) inductive conclusion, and (G) deductive conclusion.

Table 9. Improvement of Pretest and Postest Values of Creativity Aspects

Aspects of Creativity	Props Group			Poster Group		
	S_{pre}	S_{post}	Change	S_{pre}	S_{post}	Change
A	40.38	86.54	46.15	39.58	83.33	43.75
B	89.74	100.00	10.26	91.67	97.22	5.56
C	41.03	87.18	46.15	41.67	83.33	41.67
D	28.85	75.00	46.15	25.00	72.92	47.92
E	58.97	74.36	15.38	66.67	77.78	11.11
F	25.64	61.54	35.90	25.00	63.89	38.89
G	53.85	76.92	23.08	63.89	80.56	16.67

U test is used to determine the comparison of creativity between props group and posters group after PjBL model implementation. The U test results are shown in Table 10.

Table 10. U Test Result of Creativity Aspect

U_1	U_2	U_{table}	Information
143	144	35	Ho accepted

U test results show that U_1 less than U_2, so that used to compare with U_{table} is U_1. Ho in U test of creativity aspect i.e., there is no difference in creativity between props group and posters group. U_{count} more than U_{table}, so Ho is accepted.

Relation of Scientific literacy and Creativity in Project Based Learning Model

Correlation test is used to determine the relationship between scientific literacy and student creativity. The result of correlation test of scientific literacy and student creativity can be seen in Table 11.

Table 11 . The Result of Correlation Test of Scientific Literacy and Student Creativity.

Project	Correlation Test		Interpretation of Correlation	Significance		Criteria
	P_{count}	ρ_{table}		Z_{count}	Z_{table}	
Props	0,284	0,591	Weak	0,98	2,58	Ho accepted
Poster	0,171	0,591	Very Weak	0,57	2,58	Ho accepted

In corelation analysis ρ^2 called the determination coefficient because variance that occurs in the dependent variable can be explained through variants that occur in independent variables (Sugiyono, 2015:231). If the correlation coefficient value in the props group ρ = 0.284 and ρ^2 = 0.0806, then it concludes that scientific literacy of 8.06 % students is influenced by the creativity of the students themselves and 91.94% influenced by other factors. If the correlation coefficient value in the poster group ρ = 0.171 and ρ^2 = 0.0292, then it concludes that scientific literacy 2.92% is influenced by the creativity of the students themselves and 97.08% influenced by other factors.

The result of correlation test shows that there is no significant correlation between scientific literacy and student creativity, meaning that students who have high creativity do not necessarily have high scientific literacy ability, and vice versa. The implementation of the PjBL model to the class effectively enhances the creative aspect, but not effective to improve scientific literacy aspect. The creativity tests of props group and poster group achieve classical completeness, but the scientific literacy tests of props group and poster group have not yet reached a classical mastery. The implementation of the PjBL model in the XI-IPA class of SMA Muhammadiyah 3 Kayen was able to improve the scientific literacy and creativity aspect as shown by the increase of pretest and posttest values.

From the analysis of student answers on postest showed that the student is less in reading and basic skills calculations is still low. This is agreed by Anni (2004) that the less in reading, process and learning outcomes are influenced by the internal condition and external conditions of the learner. In addition to intellectual ability, scientific literacy also involves high order thingking, social, and interdisciplinary thinking skills (Nbina & Obomanu, 2010; Uki,2017).

The results showed that the PjBL model was able to improve students 'creativity aspect with students' intake was low. The acquisition of these values indicates that there are no students with zero creative thinking ability. The results are agreed by Ferrando *et al*. (2005) and Kim (2005), not always creative children are intelligent children. No one has no creativity *et al.* (Supriadi, 2001).

CONCLUSION

The implementation of PjBL on material of Dynamic Fluid in SMA Muhammadiyah 3 Kayen for five meetings can lead students into scientific literacy activities and creativity. Result of comparative hypothesis test between scientific literacy and creativity showed that no difference in scientific literacy and creativity between props group and poster group after the PjBL model implementation. Results of correlation test of scientific literacy and creativity on the props group showed that there is no significant relationship between scientific literacy and student creativity, therefore a treatment in increasing the scientific literacy can be supported by many factors besides creativity that needs a big attention. PjBL with preparing props and posters needs to be done on different classes in order to avoid biased on learning outcomes. Further research needs to be done on a wider scale so that the results can be generalized.

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