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Generative Learning Model to Improve Science Literacy Competence on 10th Grade Students of Sciences Wahid Hasyim Senior High School on Temperature and Heat Topic

Azizatuzzahro'*, Ika Kartika**
Physics Education Department, Faculty of Science & Technology, Universitas Islam Negeri Sunan Kalijaga
Jl. Marsda Adisucipto Yogyakarta 55281, Tel. +62-274-540971, Fax. +62-274-519739, Indonesia
Email: azizatuzzahro95@gmail.com*, ika_thea@yahoo.co.id**

Abstract. *Azizatuzzahro, Kartika I. 2017. Generative Learning Model to Improve Science Literacy Competence on 10th Grade Students of Sciences Wahid Hasyim Senior High School on Temperature and Heat Topic. Proc Internat Conf Sci Engin 1: 209-213.* This research was aimed to determine the effect of generative learning models on the competence of science literacy and to know the difference in the side of improvement of students' science literacy competence compared with control class on temperature and heat focus lesson. This educational research was a quasi-experiment research with Nonequivalent control group design. The independent variable of this research was generative learning model and the dependent variable was students' science literacy competence. This research was conducted in of one school in Sleman through saturated sampling technique. The experiment class is 10th grade students of 1st class and the control class is 10th grade students of second class. We used pretest and posttest as data collection instruments. The data analysis used descriptive statistic with measure of central tendency and size of dispersion include Normalized Gain and effect size. The result of this research showed that there was an effect of generative learning model in case of students' science literacy competence on temperature and heat focus lesson with average 38,00 for pretest and 79,20 for posttest. There was also improvement on students' science literacy competence with moderate improvement category, which was indicated by N-Gain value of experimental class 0.66. The control class which was treated with direct instruction model was also increased with N-Gain value of 0.48 or included in the moderate category also. The improvement of the experimental class has a very significant difference with the control class indicated by the effect size value of 1.028.

Keywords: Generative model, science literacy, temperature

INTRODUCTION

Based on a worldwide research project organized by the OECD (Organization for Economic Cooperation and Development) in PISA (International Student Assessment Program) showed unsatisfied result of indonesian students' literacy (Johar, 2012: 30). Students in modern era, 21st century, are not only required to have the ability to memorize lessons and calculate mathematical formulas, but also life skills that able to help them following technological developments and progress of times. One of life skills that must be owned is science literacy.

Science literacy is a very important to be mastered because it is closely related to how someone can understand environment and other problems faced by modern society. Science literacy leads students explaining events in everyday life, students are also required to apply the concepts that have been obtained in life (Depdiknas, 2007: 6). The following is indonesian ranks of science literacy in PISA from 2000 to 2015;

Table 1. Science literacy ranks of Indonesian students.

Year	Indonesian Average	International Average	Indonesian Rank	Countries Participants
2000	393	500	38	41
2003	395	500	38	40
2006	393	500	50	57
2009	383	500	60	65
2012	382	501	64	65
2015	403	493	62	70

Scientific literacy competence aspect of PISA includes several natural science-based subjects. One of them is physics. Based on the urgency of this matter, physics teachers should begin to provide new breakthroughs related to learning systems that can improve students' science literacy competence by improving learning process. To improve the activity of students in carrying out teaching and learning activities

teachers should be able to determine learning system approach accordance with subject matter taught. This is where the importance of teachers in building students' concept by applying models of learning that emphasizes students' activity and the outcomes to be achieved in general (Mulyasa, 2010: 53).

Improving science literacy in physics matter can be done by creating innovative learning, involving cognitive, affective, and psychomotor. For optimizing students' science literacy, teachers are able to design active learning process involving students. One of innovative learning that attends students' potential in these three aspects is generative learning model (Wulandari, 2014: 4). Generative learning requires students to understand concepts and build their own understanding. Students should also be able to apply physics to solve problems related to their daily lives. Learning model that can improve it is a generative learning model that is designed according to the view of constructivism.

Based on observations with two teachers in SMA Sains Wahid Hasyim Yogyakarta obtained data that physics learning done in the class has not facilitated students yet to develop science literacy optimally. This is due to several things. First, physics learning done in the classroom has not been fully departed from scientific phenomena, although in fact there are examples of such scientific phenomenon, so there is no chance of students to generate inquiry questions. Secondly, experimental activities is rare executed. These activities can train students to improving their ability to evaluate and design scientific research. This was supported by the opinion of one of the physics teachers at school who stated that when experimental activities were held, the activity was more of a cookbook and was not trained to identify experimental variables. Third, students are poorly trained to work on problems that prioritize science literacy related to real life, thus less training in the use of knowledge and ability to apply students' concepts.

Observations showed that most of students consider physics material is difficult. The average value of daily test obtained was below KKM (Minimum Achievement Criteria). In this case, material that can be studied is temperature and heat matter in which the example of problems easily found in everyday life. However, sometimes students still confused when faced problems involving application and mathematical analysis.

Above problems required alternative solution by applying generative learning model in process of physics learning. Learning with this generative model was chosen because the learning process involves students' ability to maximally develop concept, law or principle through exploration, focusing, challenge, and application. Based on above description, researcher is interested in conducting research by applying generative learning model on temperature and heat topic to improve science literacy competency of SMA Sains Wahid Hasyim Yogyakarta students.

MATERIALS AND METHODS

Study Area

This study was conducted using quasi experimental design with pre-posttest design involving a control group. Literacy science test based on Temperature and Heat topic was developed by researcher along with generative learning model developed by Osborne and Cosgorve (Wena, 2009) was used in this study. Data collection tools consisted syllabus, lesson plan, students' worksheet, and science literacy test were administrated to the control and treatment groups as pretest and posttest. The researcher taught the Temperature and Heat topic to treatment group using generative learning model. The worksheets that were used in the stages of the model consisted of lesson plan materials, Temperature and Heat experiments, and questions that refer to specific readings. The same topic was taught to control group using direct instruction learning model as normally used in school, Power Point presentations and also questions and answers.

Procedures

Course of Teaching in Treatment Group

At the beginning of learning, general information on Temperature and Heat was briefly described. This group was taught according to the generative learning model within the frameworks of determined context.

Preliminary Phase

Students in the treatment group were explored their initial ideas, experiences or concepts related to Temperature and Heat topic which occurs in everyday life. Students were handed out worksheet on the topic of the day. A passage from the first part of the worksheet about a daily life event was read along with the students. Relevant context were given to students to arouse their curiosity. Students then participated in a discussion where questions about the reasons for the event were asked.

Focus Phase

In the focus phase of generative learning model, experiments were performed to concretize the perceptions of students that were acquired at preliminary phase. Later on, the observations of students during the experiment and their conclusions were discussed. Following the experiments, students' theoretical knowledge about Temperature and Heat were clarified.

Challenge Phase

In the challenge phase of generative learning model, students completed the activities on the worksheet. The activities enabled students to achieve their missing knowledge and establish links with their existing knowledge. Students were facilitated to exchange their ideas each other.

Application Phase

In the final phase of generative learning model, students tried to solve the problems on worksheets selected from daily events related to Temperature and Heat using the

knowledge they had attained. A general evaluation together with the students was made about their understanding about Temperature and Heat. During the evaluation, the main focus was on enabling students to link their existing knowledge with the new knowledge.

Course of Teaching in Control Group

The control group was taught about Temperature and Heat using direct instruction learning model. The topic was introduced according to the lesson plan that was prepared. The researcher used question & answer technique and also PowerPoint presentations during the lesson.

Data Analysis

Data collection tools were checked by experts for getting judgment experts in order obtaining the internal validity, then administrated to 25 students who have gotten the topic for obtaining external validity, reliability, difficulty, and discrimination index. Researcher used the valid tools for doing experiment. Researcher evaluated data obtained from each group. Students in treatment group were interviewed before the study and were informed the procedure of instruction. Students were aware that they were a part of the experimental group, to avoid the performance change risk; these students were subject to improve science literacy competence.

This study was conducted with 10th grade students from Sains Wahid Hasyim Senior High School. The data analysis used descriptive statistics with measure of central tendency and size of dispersion include Normalized Gain and effect size.

RESULTS AND DISCUSSION

Central Tendency of Science Literacy Competence

The measure of central tendency of science literacy competence data serves to determine the centralization of data distribution. The size of the central tendency includes mean (mean), median (mean data value), and mode (frequent values) is presented below.

Table 2. Central tendency of science literacy competence.

Group	Pretest			Posttest		
	Mean	**Median**	**Modus**	**Mean**	**Median**	**Modus**
Treatment	38,00	40,00	40	79,20	80,00	80
Control	41,20	40,00	40	71,20	70,00	70

Based on above table, it can be seen that size of central tendency before being treated in control group has a relatively higher value than the treatment group. The treatment group has an average pretest value of 38.00 and the control group has an average pretest value of 41.20. The other data also showed relatively increasing.

Dispersion Size of Science Literacy Competence

Dispersion size of science literacy competence serves to determine the magnitude of deviation or data distribution to its central value. The size of dispersion consisted of range and standard deviation.

Table 3. Dispersion size of science literacy competence.

Group	Pretest				Posttest			
	Max	**Min**	**Range**	**Standart Deviasi**	**Max**	**Min**	**Range**	**Standart Deviasi**
Treatment	50	20	30	8,660	100	70	30	8,124
Control	60	20	40	10,132	90	60	30	8,813

Based on above table, it can be seen that both treatment and control groups have a tendency to measure the dispersion. The size of the control group dispersion at the time of pretest tends to be higher with the highest value is 60, the lowest value is 20, and standard deviation is 10.132. After treatment, the treatment group dispersion size decreased with the highest value of 100, the lowest value of 70, and the standard deviation of 8.124. Meanwhile, the size of the control group dispersion also has a downward trend after being treated.

Size Location of Science Literacy Competence

The size location of science literacy competence is aimed to find out location of a competence value in an ordered data distribution. One of the placement sizes can be expressed in quartile form as presented below.

Table 4. Size location of science literacy competence.

Group	Pretest			Posttest		
	Q_1	Q_2	Q_3	Q_1	Q_2	Q_3
Treatment	35	40	40	70	80	80
Control	35	40	50	65	70	80

Based on above table, it can be seen that size of treatment and control group have different initial conditions and both tendencies increase after being treated. Quartile two (Q2 or median) in the treatment group when pretest has a value of 40. After being treated, the posttest result of the treatment group changes the location of the two quartiles (Q2 or median) to 80.

Classification of Science Literacy Competencies

Classification of students science literacy competence is measured to determine the level students' science literacy in solving problems. Classification is done by analyzing the answers on given multiple choice as presented below.

Table 5. Classification of science literacy competencies.

Criteria	Experiment		Control	
	Pre-test	**Post-test**	**Pre-test**	**Post-test**
Very Good	0%	20%	0%	8%
Good	0%	48%	0%	20%
Enough	0%	32%	0%	70%
Poor	0%	0%	4%	0%
Very Poor	100%	0%	96%	0%

Based on data above it can be made a bar chart presented in the following figure:

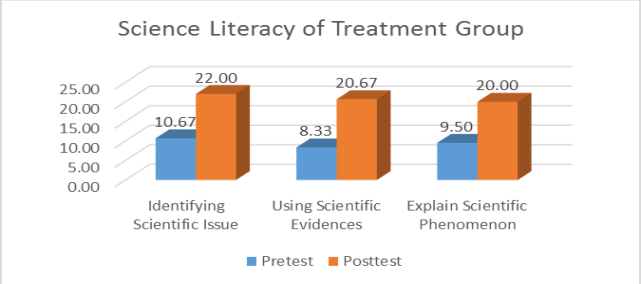

Figure 1. Chart science literacy of treatment group.

Above diagram of Pretest and Posttest Results of Treatment group Based on the diagram above shows an increasing in each competence indicator of science literacy in treatment group. Before being treated, the ability of treatment group in terms of identifying scientific issues has a score of 10.67 whereas after being given treatment, its ability rises to 22.00. Using scientific evidence indicator, before the treatment given the student has a score of 8.33 and after being treated to 20.67. In terms of explaining scientific phenomenon, the pretest score appears to be 9.50 and after being given the treatment of generative learning scores to 20.00. This suggests that generative learning can significantly increasing science literacy competence.

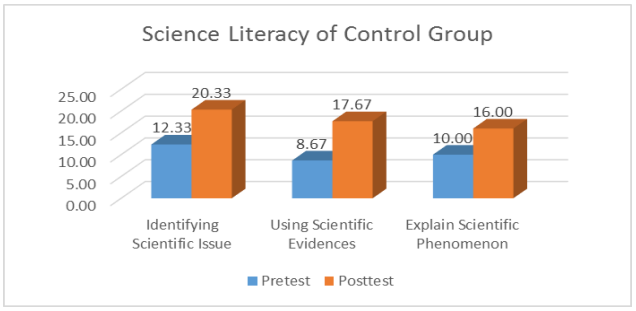

Figure 2. Chart science literacy of control group.

Before being treated, students' ability in control group in terms of identifying scientific issues has score of 12.33 whereas after being given treatment using direct instruction model the ability to rise up to 20.33. In using scientific evidence indicator, seen before the treatment given the student has a score of 8.67 and after being treated up to 17.67. While the ability of students in terms of explaining scientific phenomena, visible scores obtained at the time of pretest is 10.00 and at the time of posttest score up to 16.00. This shows that learning by using direct instruction model can also improve science literacy competence.

N-Gain of Science Literacy Competence

N-Gain calculation is used to see the increasing of students' science literacy in treatment and control group after being treated. N-Gain calculations are performed by reducing the posttest score against pretest score. Description of N-Gain calculation data of science literacy competence in treatment and control group are presented as follows.

Table 6. N-Gain of science literacy competence.

Class	N	Sum	Mean	Criteria
Experiment	25	16,43	0,66	Sedang
Control	25	12,12	0,48	Sedang

This shows that increasing science literacy competence in both classes is in medium criterion. However, the average score of N-Gain in both classes showed that science literacy in treatment group is higher than control group (0.66> 0.48). To know the difference in level of improvement is calculated by effect size

analysis. The value of effect size obtained is in high category of 1.028 where according to Lee A. Beker (2003: 3) high category is if the value of coefficient Cohen d More than or equal to 0.8. It can be interpreted that the calculation of effect size shows the difference in the increasing of students science literacy competence in both classes is very significant with higher increasing in the treatment group.

CONCLUSIONS

The result of this research showed that there was an effect of generative learning model in case of students' science literacy competence on temperature and heat focus lesson with average 38,00 for pretest and 79,20 for posttest. There was also improvement on students' science literacy competence with moderate improvement category, which was indicated by N-Gain value of experimental class 0.66. The control class which was treated with direct instruction model was also increased with N-Gain value of 0.48 or included in the moderate category also. The improvement of the experimental class has a very significant difference with the control class indicated by the effect size value of 1.028.

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