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THE EFFECTIVENESS OF PROJECT-BASED MULTI-REPRESENTATION DISCOURSE ON JUNIOR HIGH SCHOOL STUDENTS' SCIENCE PROCESS SKILLS

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Abstract

The purpose of this study was to determine the effectiveness of the implementation of Project-based Multi-Representation Discourse model in improving students' science process skills. The method used was the quasi-experiment with pretest-posttest control group research design. The population in this study was VII graders of SMP N 17 Tegal. The sample was selected using the cluster random sampling techniques. The data were taken through tests, questionnaires, and documentation. The results showed that the students learning using the Project-based Multi-Representation Discourselearning model had an average N-gain percentage of 72.27%. The percentage score was higher than the students studying using the Multi-Representation Discourse (MRD) learning model which had an average N-gain percentage of 42.50%. The results of the data analysis showed that the Project-based Multi-Representation Discourselearning model is effective enough to be applied and has an effect on improving science process skills.

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INTRODUCTION

The 21st-century education has entered in the era of the industrial revolution 4.0, an era of disruptive innovation where education is developing very rapidly (Nofrion, et al., 2018). Indonesia, as a large country, must be able to develop a culture of literacy integrated with the curriculum (Hayati, 2019). The world change must be accompanied by educational practices that are relevant to the demands for change to achieve the stated educational goals following Act No 20 the Year 2003 Article 3.

Education is a conscious effort deliberately designed to achieve goals. However, today's educational process in schools remains for transferring knowledge and is not enough to generate creative and innovative students (Irwanto & Prodjosantoso, 2016). New standards of student competence are needed so that they have the knowledge and ability to implement their knowledge in society. Schools are also challenged with how to enable students to succeed in work and life through mastering creative thinking, solving problems flexibly, collaborating and innovating.

Teaching and learning process management is a systematic effort that can be done by teachers to solve existing problems so that the learning process is expected to run effectively and efficiently to achieve the objectives. Take an example of science learning in junior high school. Science is concerned with finding out and doing thus it is not only mastering a collection of knowledge of facts, concepts or principles, but also a process of discovery. One of the outputs expected by students to have the science process skills.

Science process skills are all the skills needed by students to acquire, develop, and apply science concepts, principles, laws, theories, intellectual skills, physical skills, and social skills (Ramdan & Hamidah, 2015). The science process skills consist of 5 skills including observing, grouping, asking questioning, applying concepts, and communicating.

One of the things to improve students' science process skills is by applying the Project-Based Multi-Representation Discourse(MRD) model. Multi-Representation Discourse(MRD) is learning-oriented to the formation, use, and utilization of various representations with class settings and group work (Elfiana & Hariyono 2019). MRD's Learning Objective is to solve problems, answer questions, enrich and understand students' knowledge, and make a decision. MRD model can be assisted by using tools or media. At this point, teachers could be creative by asking students to create the media, which makes the learnings based on the project. According to Mihardi, et al (2013). Project Based Learning (PjBL) is learning that allows teachers to manage classroom learning by involving project work. The project work aims to increase student creativity and motivation since it is seen as a form of open-ended contextual activity-based learning and is part of the learning process in problem-solving. Project work can also lead to scientific inquiry skills, instilling the conceptual attitudes and perspectives needed in scientific inquiry (Hayati et al, 2013). Steps in the Project-Based Multi-Representation Discourse learning include:

1. Preparation
2. Introduction
3. Implementation
   a. *Planning*
   b. *Scheduling*
   c. *Monitoring*
   d. *Assessing*
4. Closing

The explanation of the steps are as follows:

1. Preparation

   The teacher prepares a learning device, followed by managing the students to be ready to receive learning. The teacher opens the learning with greetings and prayers then informs about the Project-Based Multi-Representation Discourselearning. Next, the teacher divides students into 6 groups and asks them to sit close to their respective group members.

2. Core Activity

   The teacher encourages students to recall previous knowledge before receiving new knowledge. Teachers and students conduct question and answer in a structured manner followed by group discussions. They are given a problem to solve and after finding the solution, they should present it in front of the class.

   After presenting the discussion results, the teacher directs students to plan a project. Teachers and students collaboratively arrange activity schedules to complete the formulated projects. The projects are carried out to compile and strengthen answers to the problem-solving questions raised in the

previous discussion. The teacher is responsible for monitoring students while completing the project and assessing the outcome using the authentic assessment.

3. Closing

The teacher reinforces the student answers. The teacher and students together make evaluations and conclusions on the results of discussions and projects then learning closes with prayer.

The Project-Based Multi-Representation Discourse learning phase, starting from the introduction up to the closing activities, contains a certain aim to achieve the science process skills. Furthermore, the problems to answer in this research are: 1) is there an increase in the students' science process skills taught using the Project-Based Multi-Representation Discourse learning model?, and 2) how is the effectivity of the Project-Based Multi-Representation Discourse learning?

METHODS

This research employed the quasi-experiment method with a pretest-posttest control group design (Frankel dan Wallen, 2009). Table 1 informs the types, techniques, and instruments of data collection.

Table 1. Types, Techniques, and Instruments of Data Collection

Type	Data Collection Technique	Instrument	Data Analysis Technique
Instrument validation	Validation questionnaire *Checklist*	Validation sheet	Descriptive
Science process skills	Observation Test	Assessment sheet Test sheet	Descriptive percentage
Student responses	Questionnaire *Checklist*	Questionnaire	Descriptive percentage
Learning results	Test (Cognitive) Observation (Psychomotor)	Objective test sheet Observation sheet	Descriptive & Statistics percentage Descriptive percentage

The research was conducted at SMP N 17 Tegal City in the even semester of the 2018/2019 academic year. The population was all VII graders and the sample was selected using cluster random sampling techniques. The sample included the 30 students of class VII A and 30 students of class VII B. The first class applied the Project-based Multi-Representation Discoursemodel while the latter implemented the MRD model. The research design is seen in Table 2.

Table 2. *Pretest-Posttest Control Group Design*

Sampling technique	*Pretest*	Independent Variable	*Posttest*
R	O	X	O
	O	C	O

Information:

O = Test of science process skills

X =Project-based Multi-Representation Discourselearning

C =*Multi-Representation Discourse* (MRD) learning

The instruments used in this study were the test of science process skills and observation sheet. the test intends to determine students' science process skills in the cognitive domain, while the observation sheet is used to find out students' science process skills in the psychomotor domain. To obtain a good instrument, expert validation was first carried out on test items and learning tools (worksheet, lesson plan, and questionnaire) which were analyzed using the Aiken V formula as follows:

$$V = \frac{\sum s}{n\,(c-1)} \quad (1)$$

(Aiken, 1980)

Further, the validation assessment criteria based on the Aiken V could be seen in the following Table 3.

Table 3. The validation assessment criteria based on the Aiken V

Aiken V scale	Validity
$V \leq 0.4$	Low
$0.4 < V \leq 0.8$	Medium
$0.8 < V$	Valid

The recapitulation of the validation results is presented in Table 4.

Table 4. The recapitulation of the validation results

Instrument	*Aiken V* score
Test item	0.84
Learning device	0.833

The total Aiken V score was 0.83 which means that the test questions and learning tools are declared valid and worth testing for this study. The science process skills test, in addition to being validated by an expert, was also tested on a test class, namely class VII E at SMP N 17 Tegal City using the Rasch test model. According to Andrich (2011) the basis for Rasch modeling as a modern measurement theory in the field of education was derived by the simplest pair comparison. The following Table 5 presents valid test criteria.

Table 5. The Validity Test Criteria

Item Match Test	Criteria
p-value	P > 0.01
Z-Standart outfit (ZSTD)	0.2 < ZSTD < + 2.0

The validation process generated 41 valid test items of 43 items. The pretest and posttest items' reliability were respectively $0.85 \leq r < 0.91$, thus, the items were categorized as good.

The results of the science process skill test were then analyzed descriptively and statistically using the precondition and hypothesis test. The precondition test consists of normality (*Kolmogorov-Smirnov test*) and homoge*neity (Levene test*) test. The hypotheses test includes the t-test (*independent samples t-test*) and N-gain using the SPSS 17.0 statistics software. On the statistical test, the significance level (α) was 0.01. Further, the H0 is rejected and Ha is accepted if Sig. (1-tailed) <0.01. On the other hand, the N-gain test used to determine the effectiveness of the learning model can be categorized as in Table 6.

Table 6. The N-Gain Effectivity Category

Percentage (%)	Category
< 40	Not effective
40 – 55	Less effective
56 – 75	Partially effective
> 76	Effective

Attitude scale is a collection of statements about an attitude (Azwar, 2013). In this case, it was analyzed through a questionnaire handed out to the students who experienced the Project-based Diskursus Multy Reprecentacy. The analysis was done by looking at the students' answer tendency using the following formula:

$$\text{Respondents' perspective} = \frac{\textit{Respon Item}}{\textit{Total Responden}} \text{ x } 100\% \quad (2)$$

RESULTS AND DISCUSSION

The science process skills of the students in both classes were assessed using the objective test. The test was done twice, before and after the learning implementation. The averages of the pretest, posttest, and gain score <*g*> of the two classes are presented in Table 7.

Table 7. The averages of the pretest, posttest, and gain score <*g*> of science process skills

Class	Test	Nmin	Nmax	X	*Gain score <g>*
Project-based Multi-Representation Discourse(1st class)	*Pretest*	10	70	38.33	0.72
	Posttest	70	100	84.43	
			Criteria:		High
Multi-Representation Discourse(2nd class)	*Pretest*	10	60	35.67	0.42
	Posttest	50	80	64.67	
			Criteria:		Medium

Table 7 reveals that the science process skills of the students at both classes were raising yet in a different number. The first class averagely gained 38.33 and the second class obtained 35.67 for the pretest. Moreover, the averages posttest scores in the two classes were respectively 84.43 and 64.67. further, the gain score of the first class was 0.72 and categorized as 'high' while the gain score of the second class was 0.42 and classified as 'medium'. The average of the posttest scores was then analyzed descriptively and the results are as seen in Figure 1.

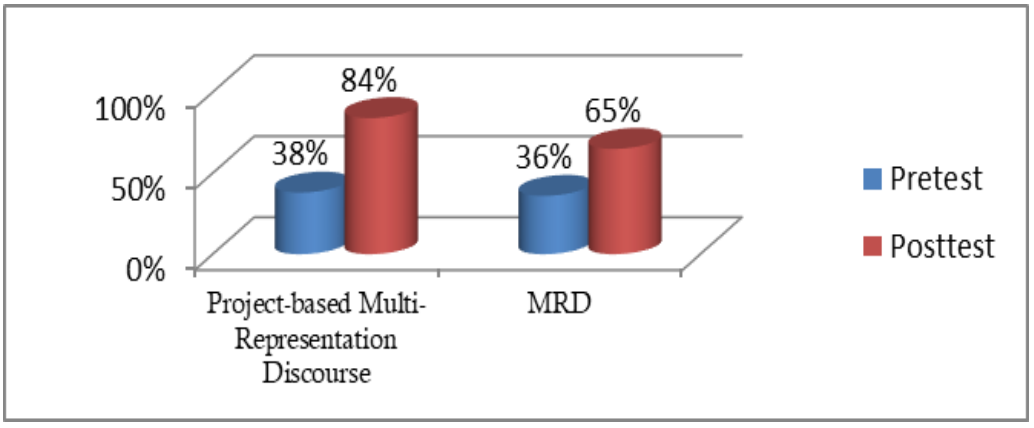

Figure 1. The Analysis of Science Process Skills Result

The increase in student learning outcomes is reflected through the pre- and post-test score average. The class applying the Project-based Multi-Representation Discourse obtained the average pretest and posttest score of 38.33 and 84.43 or 46.1 of an increase. On the other hand, the MRD class' average pretest was 35.67 and 64. 67 for the posttest, resulting in an average increase of 29.

The increases in science process skills measured using the observation sheet are seen in Figure2.

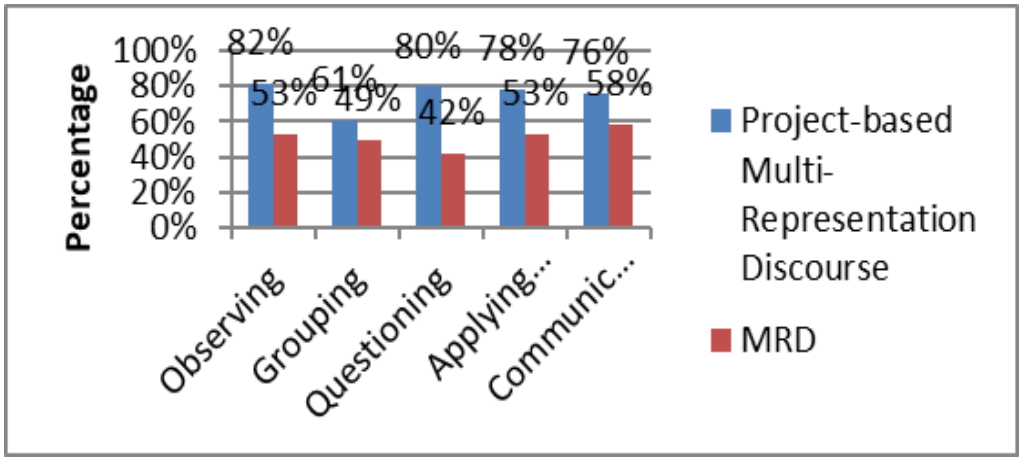

Figure 2. The analysis results of science process skills based on the observation sheet

Referring to Figure 2, the scores of science process skill indicators in the first class were 82% for observing, 61% for grouping, 80% for questioning, 78% for applying the concept, and 76% for communicating. On the other hand, the second class applying the MRD achieved 53% for observing, 49% for grouping, 42% questioning, 53% for applying the concept, and 58% for communicating.

Seen from the average learning results, the students in both classes experienced an increase. The first class implementing the Project-Based Multi-Representation Discourseobtained an average above the mastery learning criteria. A learner is said to be completing the mastery learning if s/he gets 75 or above. Any other way, the students in the second class did not pass the mastery learning criteria.

Similarly, the psychomotor aspect of the students in the first class was higher than the students in the second class. The class of Project-Based Multi-Representation Discourseobtained 75.33% while the MRD class obtained 50.83%. Clearer differences in results per indicator of science process skills are described as follows:

a. Observing

The average observing scores of the class applying the Project-based Multi-Representation Discourseand the class implementing the MRD were respectively 82% and 53% or having a 29% deviation. Observing is one of the fundamental scientific skills. Students must be able to use all of their senses including seeing, hearing, feeling, tasting and smelling. Hence, with the Project-based Multi-Representation Discoursemodel, all senses can be optimized, especially in project-based learning steps. This is in line with Dudu & Vhurumuku (2012) who stated that the basic skills students must have in conducting scientific investigations are the ability to observe which uses the five senses to obtain data or information.

b. Grouping

The average grouping scores of the class applying the Project-based Multi-Representation Discourseand the class implementing the MRD were respectively 61% and 49% or having a 12% difference. Hamalik (2009) explained that grouping is a skill in sorting out differences and similarities of the observation results on a particular characteristic, objective, or object interest.

This indicator had the smallest deviation compared to other indicators as the students in the class applying the MRD have been accustomed to grouping. This skill is developed through both direct exposure by the teacher in the classroom and the experimental activities conducted. Student worksheets are preceded by theories related to experimental activities as a beginner skill (Rudimentary skill) Wenning & Khan (2011).

c. Questioning

The average observing scores of the class applying the Project-based Multi-Representation Discourseand the class implementing the MRD were respectively 80% and 42% or having a 38% deviation. Questioning means asking for an explanation about what, why, and how things happen or a hypothesis. The low verbal skills have been accused as the cause of the very low score for this indicator in the class with MRD. Hence, the students' verbal skills have to be honed for them to be able to ask questions chronologically and well-understood by others.

d. Applying Concept

The average grouping scores of the class applying the Project-based Multi-Representation Discourseand the class implementing the MRD were respectively 78% and 53% or having a 25% difference. This difference in results was due to the student involvement in problem-solving investigations at the Project-based Multi-Representation Discoursemodel. The activities allowed the students to work independently in constructing their knowledge, as an effort to generate real products (Holm, 2011) as a result, this class scored better for the indicator.

e. Communicating

The average grouping scores of the class applying the Project-based Multi-Representation Discourse and the class implementing the MRD were respectively 76% and 58% or having an 18% difference. The communication skills include the ability to read graphs, tables, and

diagrams as well as making up and explain systematic, clear reports. This is supported by *Intel Corporation* through *Intel Teach Program* (in Sutirman, 2013) that project-based learning provides chances for the students to develop complex skills like higher-order thinking, problem-solving, cooperating, and communicating so that the MRD class result of the indicator was lower.

The MRD model, as stated by Tristiyanti (2012) is a learning model that could train students to cooperate and exchange opinions as well as knowledge to solve problems. Its integration with the PjBL enables students to use problems as the initial step in collecting and connecting new knowledge based on their experience (Wahyu, 2017). In other words, the Project-based Multi-Representation Discoursecould enhance the students' science process skills during science learning.

Seeing the above explanation, the Project-based Multi-Representation Discoursemodel is effective in improving science learning outcomes in the cognitive domain and science process skills in the psychomotor domain. These enhancements could be achieved due to the guidance provided by the teachers during the discussion, experiment, and presentation process. It is also in line with Piaget stating that knowledge would be meaningful when searched and discovered by learners. The knowledge is earned when learners respond to a certain stimulus, which will lead them to get physical knowledge and finally transfer it into ideas (Saputra, 2019).

The Hypothesis Testing of the Enhancement of Science Process Skills and the Effectivity of the Project-based Multi-Representation Discourse Model

The research results showed that the Project-based Multi-Representation DiscourseModel has contributed to the increase in the students' science process skills. In any other words, the first and second hypothesis was accepted. It can be seen from the hypothesis test results which obtained a significance score of 0.001 so that the H0 is rejected statistically. Moreover, it was supported by the N-Gain score. The class implementing the Project-based Multi-Representation DiscourseModel got an N-Gain of 72.27% and categorized as 'quite effective'. Differently, the N-Gain score obtained by the class with the MRD model was 42.50% and classified as 'less effective'. In sum, the first model is more effective than the second one.

The effectivity of the Project-based Multi-Representation DiscourseModel in enhancing the students' science process skills was due to the direct involvement of the students in the discussion and given project. This is reinforced by the prior research investigating the Diskursus Multy Reprecentacy. It reveals that the MRD model could improve learners' creative thinking skills (Agustina, 2017). Further, a study by Chasanah (2016) concluded that PjBL is effective in enhancing students' science process skills.

The suitability of these findings with previous research has reinforced that the Project-based Multi-Representation Discoursemodel is effective in enhancing students' science process skills. In this research, the first class using the Project-based Multi-Representation Discoursemodel got 84% and the class implementing the MRD obtained 65%.

The Students' Response to the Project-based Multi-Representation DiscourseModel

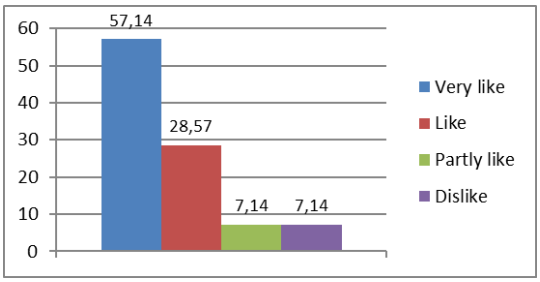

Figure 3. The Questionnaire Analysis Results

The analysis results in Figure 3 show that the students are happy with the Project-based Multi-Representation Discourse model on solar system topics. The results showed that among 30 students, 57.14% of students answered 'very like', 28.57% of students answered 'like', 7.14% of students answered 'partly like' and 7.14% of students answered 'dislike'. In sum, the students who 'really like' and 'like' was 85.71%.

This study has several shortcomings: 1) Cluster random sample was used by randomizing the class; 2) limited research time, as the study was conducted during Ramadan where 1-hour lesson equals to 30 minutes; and 3) the science process skill measurements cannot be properly analyzed at each meeting.

CONCLUSION

This research concluded that the Project-based Multi-Representation Discourse could influence the increase in the students' science process skills and is effective in contributing to the enhancement of science process skills.

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