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The Effect of Project in Problem-Based Learning on Students' Scientific and Information Literacy in Learning Human Excretory System

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ABSTRACT The present study aims to investigate the effect of Project in Problem-Based Learning on students' scientific and information literacy in grade 8 studying in one of the private schools in Bandung in the human excretory system topic. A sample of 39 students in two classes was selected purposively from the five classes available in the school. An experimental group comprising 19 students received the instruction by Problem-Based Learning with the project at the end of the lesson while the control group comprising 20 students received the human excretory instruction by using Problem-Based Learning without a project. The data was collected via the pre-test and post-test administration. The results were statistically analyzed using SPSS software by employing an independent t-test. Results indicated that after the one-month treatment period, students in the experimental group have a higher score in the scientific literacy test compared to the students in the control group even it was not significantly different. Therefore, the results of students' information literacy showed that there was a significant difference between the experiment and control group. It is concluded that Project in problem-based learning is useful to conduct as the learning strategies in the classroom to improve students' scientific and information literacy.

Keywords Project in Problem-based learning, Scientific literacy, Information literacy

1. INTRODUCTION

Science is considered one of the hardest subject matters in school. It requires many theoretical readings, calculation, and formulas, difficult terms, and content memorization. According to Cimer (2012), students have difficulties in learning biological concepts because of the nature of science itself, its teaching methods, and lack of facilities, media, and resources. While in learning chemistry, Cardellini (2012) stated that students have difficulties in chemistry because of the nature of science, the methods of teaching, and the methods by which students learn. Whereas students have difficulties in learning physics because of the nature of physics, the way in which a physics course is taught, and the physics problems which are sometimes very vague and cumulative (Ornek, Robinson, & Haugan, 2008). Those factors make students pay less attention in the class, easily lose concentration, feel bored, and uninterested in learning science.

The nature of science becomes one of the reasons why sciences are hard and difficult to learn. The nature of biology usually includes a lot of concepts, various biological events that cannot be seen by the naked eye, abstract concepts, and there are a lot of foreign / Latin words. These nature of biology leads them to memorize the biological facts in order to learn them (Cimer, 2012). The nature of chemistry tends to the alphabetic and symbolic language, abstract concepts, and structural properties which couldn't be seen by the naked eyes (Cardellini, 2012). The nature of physics composed of many theoretical readings (such as laws and rules), alphabetic language, formulas and calculations that requires good mathematics, very abstract things, and hard to grasp the next concept when one of the concepts is missing (cumulative) (Ornek, Robinson, & Haugan, 2008). Thus, the nature of science requires very detailed knowledge and covered topics or concepts that were difficult to learn. When this topic does not appear to be relevant to the students' daily lives and does not include practical work or experiments, students will learn the topic by memorization (Cimer, 2012).

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The way the teacher taught is another common reason behind “science is hard”. According to the Cimer (2012), science lessons are generally carried out through the teacher-centered lesson. Teacher transfer the knowledge that they have without involving students in the classroom activity. The concept is also rarely connected to the daily lives so that students losing their motivation to learn science. As a result, science lesson becomes boring and uninteresting for students.

The role of the teacher becomes an important part to help students in learning science, especially in the way they deliver the concept (teaching strategy). The teaching strategy is an important thing to create an environment in the classroom become more active, engaging, and increasing the students’ participation. Fives, Huebner, Birnbaum, & Nicolich (2014) stated that science should be a recursive, dynamic process of asking questions, investigating, and then asking more questions. Akinoglu & Tandogan (2007) suggests that the student-centered active learning process within will makes students take the responsibility and involvement in the learning process. Active-learning techniques motivate students and maintain their attention by requiring them to engage in course content (Wenger, 2014). There are a lot of teaching strategies that can be used in the science teaching and learning process, such as Discovery-Based Learning, Problem Based Learning, Project Based Learning, Inquiry-Based Learning, and so on. These strategies promote student-centered learning in which they will involve in the learning activities.

In order to overcome students’ problem in science, the teacher needs a teaching strategy which is able to connect their knowledge with the real-life phenomenon, able to involve them in the classroom activity and reflect on the abstract knowledge. The strategy that meets these criteria is Problem-Based Learning (Akinoglu & Tandogan, 2007). Problem Based Learning is active learning technique that helps students to develop higher-level cognitive abilities, such as critical thinking and problem solving, through collaborative group work and reflection on their own learning (Wenger, 2014). Clayton & Pierpoint (2004) adds that PBL is a student-centered and self-directed learning model which begin the lesson with a problem, not a knowledge. Students will find the knowledge by themselves through a problem they are solved and the teacher acts as a facilitator to guide them to find the solution to a problem (Akinoglu & Tandogan, 2007).

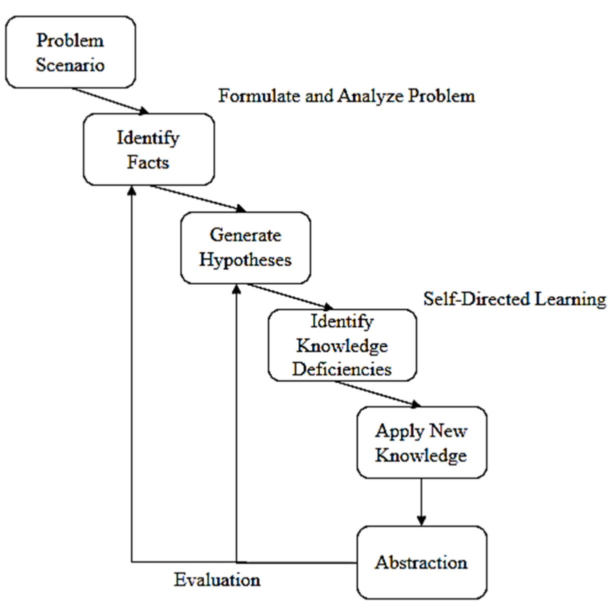

Figure 1 Problem-based learning cycle

In learning by using PBL, there is a cycle which starts with a problem scenario. According to Hmelo, Silver (2004), PBL learning cycle (as shown in Fig. 1) is represented through the instructional process that begins with the presentation of a problem and ends with students’ reflection. In this cycle, the students are presented with a problem scenario. They formulate and analyze the problem by identifying the relevant facts from the scenario. This fact-identification step helps students represent the problem. As students understand the problem better, they generate hypotheses about possible solutions. After that, students will identify knowledge deficiencies which are also known as the learning issues where students find the information to solve the problem (self-directed learning). Following SDL, students apply their knowledge and evaluate their hypotheses in light of what they have learned. At the completion of the problem, students reflect on the abstract knowledge gained. Akinoglu & Tandogan (2007) said that by using PBL approach in a learning activity, students will involve more in the process of learning and since they do some research in solving the problem, students will more understand the lesson rather than memorization.

In constructing the theories represented by the problems presented, students work collaboratively using a variety of informational resources (Akinoglu & Tandogan, 2007). The information itself is gained from various media such as books, internet, magazine, or direct interview with the expert. Therefore, it is necessary for students for being information literate so that they would be able to effectively filter information that they get through the Internet, television, newspaper, and other sources. Students also need information literacy so that they are able to locate, evaluate, and use the information effectively and efficiently, especially in science content (Association of College and Research Libraries, 2000).

According to the Montana Office of Public Instruction (2010), there are five standards of information literacy that students may learn in Grade 8. The standards are (i) to identify the task and determine the resources needed; (ii) to locate sources, use information, and present findings; (iii) to evaluate the product and the learning process; (iv) to use information safely, ethically and legally; and (v) to pursue personal interests through literature and another creative expression.

The seeking of science content in many resources is also forced students to have scientific literacy instead of having information literacy. Scientific literacy itself is the ability to understand scientific processes and to engage meaningfully with scientific information available in daily life (Fives, Huebner, Birnbaum, & Nicolich, 2014). However, the implementation of scientific literacy itself has not been a concern in all countries, such as in Indonesia. This statement is supported by the data of OECD (2016) which shown that scientific literacy for Indonesian students in 2015 is in the position of 62 from 70 participated countries. This report means that the scientific literacy of the students in Indonesia is still low. The low ability of students' literacy is influenced by several factors, they are curriculum and educational system, the method and model of learning that is used in the instructional process, learning facility, and learning sources (Kurnia & Fathurohman, 2014). The strategies to enhance students' performance in scientific literacy is by engaging them in learning activity which is student-centered such as questioning, creative exploration to find the answer, and the communication skills to present the result (Latip & Permanasari, 2015).

2. METHOD

This research used the quasi-experimental method. In quasi-experiments, the researcher cannot artificially create groups for the experiments so researcher uses the group (class) that the school already arranged to take data (Fraenkel, Wallen, & Hyun, 2012). The dependent variable of this study was students' scientific and information literacy while the Project in Problem-Based Learning is the independent variable.

A non-randomized group pre-test-post-test design was used for this study. According to Creswell (2012), the study can apply pre-test and post-test design when using a quasi-experiment as the method. The classes were randomly assigned to the experimental and control group. This study will conduct the same pre-test to the control and experimental group with the same pre-set questions. Then, the experimental group will have Project as the treatment and get a module of information literacy, while control group only have a regular problem based learning without any project and have direct instruction of information literacy. The treatment was implemented in two weekly lessons of 5 hours each. In the first meeting, both groups conducted the same pre-test on a different day. Then in the second meeting, both groups conducted the learning topic by using Problem-based learning and got a module of information literacy in the experimental group and direct instruction of information literacy in the control group. The lesson was given on a weekly basis in the period of March 2018. In the third meeting, the experimental group has guidance to create a project in the form of an article

Treatment group	*M*	*O*	*X*	*O*
Control group	*M*	*O*	*C*	*O*

Figure 2 The matching-only pretest-posttest control group design

about the human excretory system. While the control group makes a summary of diseases of the human excretory system. Pre-test data on scientific and information literacy multiple-choice questions were collected before the students learn about the human excretory system topic. Post-test data on the same variables were collected a month later, right after the intervention. Data were collected and analyzed by using the Independent T-test on SPSS software.

Both the control and treatment group subjects have been matched. The M in this design means that both groups have the same start point or the equivalent level of achievement (see Fig. 2). This was proven by the p-value on the pre-achievement test in both scientific and information literacy which showed a $p\text{-value} > 0.05$. Then, after the subjects had been matched, they have conducted the same pre-test. The subjects in the treatment group were conducting the human excretory system by using PBL model with project-based information at the end of the class meeting. Project-based Information refers to the article about a human excretory system which they sought the information freely on many resources. The PBL was combining with the project in order to encourage students to construct and make connections between their knowledge and its application in daily life through the information that they gathered. That information will be compiled in an article as the project based information. The students were guided by the module of information literacy made by the teacher. In another hand, the control group was conducting the learning with the PBL model without project-based information at the end of the class meeting. Instead of taught by PBL model, students in the control group were also got the direct instruction about the information literacy.

All participants were 8^{th}-grade students attending the one of private secondary school, located in the city of Bandung, comprising 110 students in 5 classes. The school works on the basis of the *Kurikulum* [Curriculum] 2013 developed by Indonesia Ministry of Education and Culture. The samples were two classes of 8^{th} grade. The experimental group consisted of 19 students (11 females and 8 males) and the control group consisted of 20 (11 females and 9 males) students. The age of the sample was about 14 years old. The sampling technique used was purposive sampling because the researcher needs two classes with the same average score in science since the research is using quasi-experiment.

The instruments used in this research is an objective test. The objective test is used to evaluate students' students scientific and information literacy in learning the

Table 1 The results of the detached t-test carried out regarding the difference between the pre-test scores of students in the experimental and control group

Group	N	M	SD	SE	Detached group t-test		
					df	t	p
Experimental Group	19	35.16	11.437	3.508	37	-0.558	0.58
Control Group	20	33.20	10.471				

Table 2 The results of the detached t-test carried out regarding the difference between the post-test scores of students in the experimental and control group

Group	N	M	SD	SE	Detached group t-test		
					df	t	p
Experimental Group	19	65.47	14.860	4.494	37	-1.975	0.056
Control Group	20	56.60	13.189				

human excretory system. The objective test is given in a form of multiple choice. The study administered 40 multiple choice test items of scientific literacy and 40 multiple choice test items of information literacy, then it would be discussed and selected based on the analysis result of the pilot-test instrument. Total question number that will be used for pre-test and post-test are 25 questions for scientific literacy and 25 questions for information literacy which each multiple-choice item is given a numeric value of one to correct answer and zero for incorrect.

3. RESULT AND DISCUSSION

The results show quantitative data. The pre-test and the post-test are conducted to determine the students' understanding before and after treatments.

3.1 Scientific Literacy

An independent samples t-test was conducted to compare the students' scientific literacy achievement in control and experimental class. Table 1 showed that there was a not significant difference in students' pre-scientific literacy achievement scores for control group (M=33.20; SD=10.471) and students in experimental group (M=35.16; SD=41.75; t(37)=-0.558, p=0.580, two-tailed). The 95% confidence interval for the difference in means ranging from -9.067 to 5.151. Hence non-significant which means students in both the groups had an equivalent level of achievement of scientific literacy.

After the intervention in a month, students were conducted a post-test. An independent samples t-test was conducted to compare scientific literacy scores for students in the control and experimental group. Table 2 showed that there was not a significant difference in scientific literacy scores for students in the control group (M=56.60; SD=13.189) and students in the experimental group (M=65.47; SD=14.860; t(37)=-1.975; p=0.056, two-tailed). The 95% confidence interval for the difference in means ranging from -17.979 to 0.231.

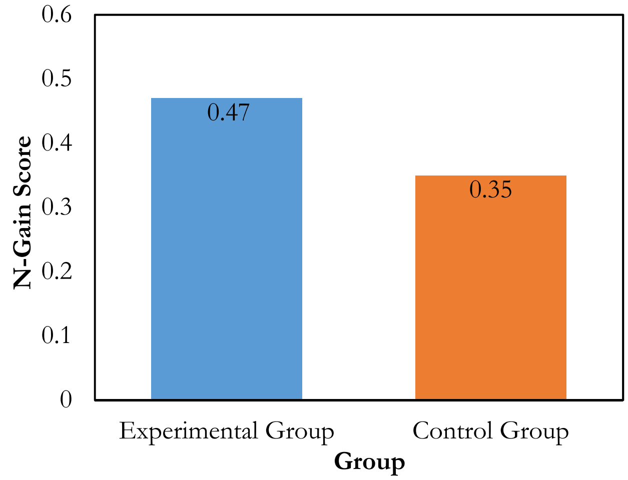

Figure 3 The normalized gain scores of students' scientific literacy

Since the post-test in scientific literacy showed there is no significance, the researcher uses N-gain to investigate the improvement in achievement of scientific literacy score. The score gained from the calculation of N-Gain in the experimental group was 0.467 and control group was 0.350 as seen in Figure 3. The score obtained according to Hake (1999) is included in the medium range. From the N-Gain score of the achievement of scientific literacy score, it can be concluded that there is an improvement of students' achievement scientific literacy score after the treatment by using Project in problem-based learning.

The implementation of Project in PBL and the regular PBL learning model can improve students' scientific literacy skills in aspects of content knowledge, science competencies, and attitude in the medium category of N-Gain. This is influenced by several factors of (i) the number of students who participate in both experimental and control group were big so that it took too much time to help them find out the concept or problem solving; (ii) the number of meeting and time in each meeting are limited. To conduct this topic, researcher was only has five hours to deliver all the concept material with 50 minutes in every hours so it was so difficult for teacher to review all the concepts after student solved the problem; (iii) the content provided by the school was varies and students should learn all of them (structure and function of human digestive organ, the mechanism of excretory system in excretory organ, the diseases in human excretory system, the effort to maintain the health of excretory organ) within 5 hours of meeting; (iv) the attendance of students were also influenced the result. Since there were only 2 meetings so that when students not participating in a day meeting in a class they were like missing half of the concept.

The students' scientific literacy in each aspect has also improved well. From Figure 4, it showed that the knowledge domain, the improvement of scientific literacy's achievement after conducting an intervention was 24% in the experimental group and 15% in the control group. In

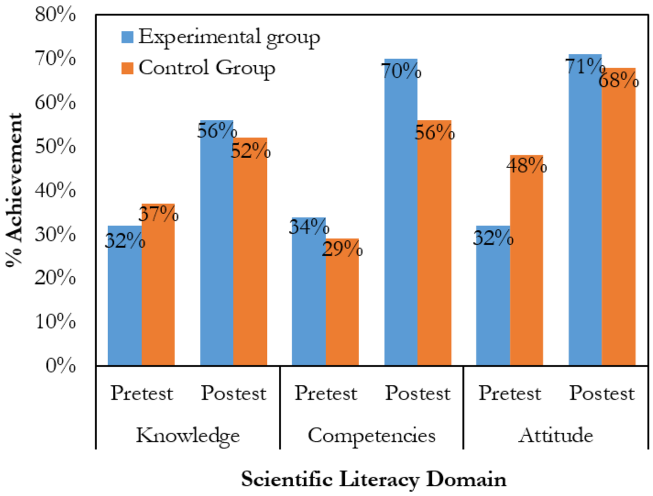

Figure 4 The scientific literacy achievement percentage in every domain

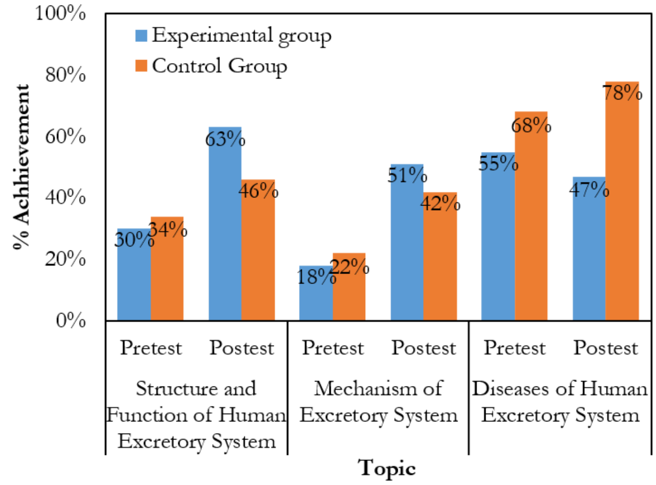

Figure 5 Profile of improvement content mastery achievement of human excretory system after learning process using PBL models

the competencies domain, the improvement was 36% in the experimental group and 27% in the control group. Whereas in attitudes domain, the improvement was 39% in the experimental group and 20% in the control group. The results showed that the highest improvement in the experimental group was in the attitudes domain with 39% and in the control group was in competencies domain with 27%.

Analysis of scientific literacy knowledge conducted to determine the profile of Human excretory system material mastery. The human excretory system is divided into four topics of structure and function of the human excretory organ, the mechanism of the excretory system in every excretory organ, and the diseases of the human excretory system. Figure 5 shows the improvement in students' achievement for every content material that was discussed in the learning process. Overall, Problem-based learning whether or not using a Project, it can improve science content mastery achievement. In the sub-topic of the structure and function of the human excretory system, there was an improvement of about 33% in the experimental class and 12% in the control class. In the mechanism of the excretory system, there was an improvement of about 33% in the experimental class and 20% in the control class. In the sub-topic of diseases of the human excretory system, there was an improvement of about 10% in the control group while in the experimental group the score decreased by about 8%. The highest improvement was in the structure and function of the human excretory system for the experimental group that uses Project in PBL and diseases of a human excretory system for the control group who doesn't use Project.

Results of students' activity observation showed that the dominant activity during the learning process with Project with and without PBL was the discussion and students' observation. This means that those activities conducted by students contributed positively to students' understanding of these content. In the discussion process, students got the worksheet contained problems related to the topic. Students were having a discussion and have some exploration due to solving the problems. After the discussion activity was completed, the teacher also gave review related to the problem presented about those content material through questioning. This is in line with Inel & Balim (2010) who stated that the use of the Problem-based learning method in science is more effective in enhancing students' academic achievement because the active role played by the students in the process of PBL from the problem identification to solving the problem and by constructing their own knowledge in the collaborative group.

Besides students' knowledge domain, this study was also examined students' thinking competence after obtaining science learning using Project in PBL models. According to Ardianto & Rubini (2016), a person said to be literate when he is not only proficient with conceptual terms, but also their way of thinking to solve the problem using their knowledge. Student competence revealed in this research to the scientific literacy indicators recommended by the Programme of International Student Assessment (PISA) in 2015. They are "Identifying scientific issues", "Explaining phenomena scientifically", and "Using scientific evidence". Overall performance shows improvement of students' science knowledge after using PBL models in science learning can be seen in Figure 4.

Figure 6 shows that the achievement of students' science competencies overall showed encouraging results. The research revealed that the indicator of "explain phenomena scientifically" improved 32% for Project in PBL and 34% for PBL only. Then for the indicator of "Identifying science issues: it improved 58% for the experimental class and 25% for the control class. And for the indicator of "Using scientific evidence, it improved 35% for the experimental class and 21% for the control group.

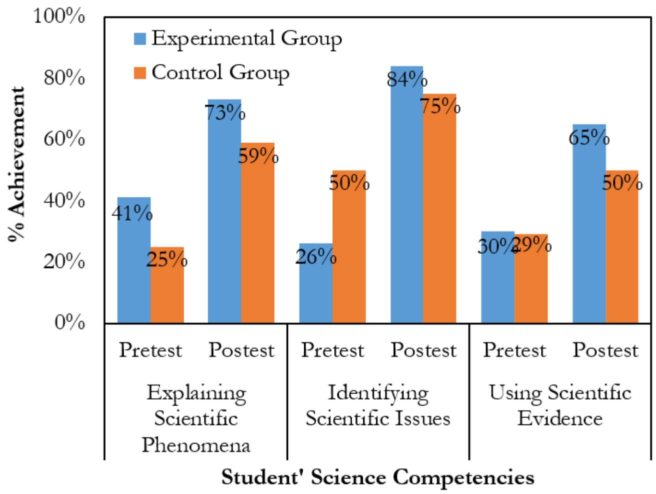

Figure 6 Improvement of student' science competencies after using PBL with and without project in science learning

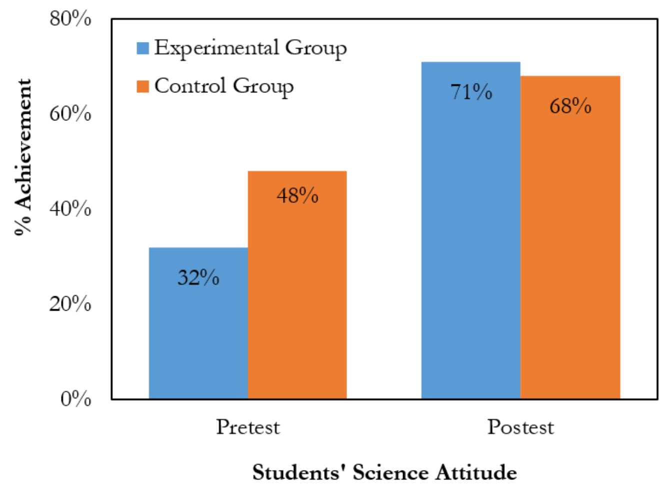

Figure 7 Improvement of students' science attitude after using PBL models in science learning

The improvement of students' competence in each indicator was because the implemented learning model emphasized students' independence and thinking skills. Basically, the model is applied in the classroom to give students an opportunity to practice recognizing scientific issues in the learning process to solve the problems. This is in line with the research finding of Ardianto & Rubini (2016) that revealed students' science competency can improve through the learning process using guided discovery and Problem-based learning by solving problems through systematic stages.

Students' attitude revealed in this study refers to the scientific literacy indicators of "Environmental awareness". Overall performance shows improvement of students' attitude after using PBL in science learning can be seen in Figure 7. Figure 7 shows that the achievement of students' science attitude was encouraging results. The research revealed that the indicator of environmental awareness improved from 32% to 71% (39%) in the experimental group and from 48% to 68% (20%) in the control group. The improvement of students' science attitude was because the implemented learning model emphasized the daily life phenomenon and active learning in a collaborative group. This is in line with Akinoglu & Tandogan (2007) that the attitudes of students in PBL group showed the positive effect rather than the conventional group because the PBL provides scenario content related to daily life which removing students fear about the difficult problem-solving, facilitating learning, and making students be aware of the fact that science is a very part of life. Besides, since the PBL instruction needs students' collaboration with the group, students' cooperation and social development were also influenced positively.

The improvements in scientific literacy aspects occurred because of the Problem-based learning itself encourage students to construct their own knowledge by solving a problem in daily life. This is consistent with the research of Akinoglu & Tandogan (2007) that PBL can develop the content knowledge of students by solving the problem related to the real-world phenomenon. Baden, Manggi, Major, & Claire (2004) is also stated that Problem-based learning uses problem scenarios to encourage students to engage themselves in the learning process. Another research by Ardianto & Rubini (2016) suggests that Besides, the improvements of scientific literacy occurred because the integrated science lesson by using PBL model could encourage students to construct and make connections between their knowledge and real-life phenomenon.

The implementation of PBL models in the learning activity also gave the opportunity to students to work together with other groups in doing an investigation, so that it can develop their learning process and social skills. This is in line with the result of the research of Akinoglu & Tandogan (2007) which stated that since PBL instruction needs the collaboration of groups, the students' cooperation and social development were also influenced positively. Another research conducted by Inel & Balim (2010) showed that the use of the Problem-based learning method in science and technology teaching is more effective in enhancing students' academic achievement than conventional method because the active role played by the students in the process of PBL from the problem identification to solving the problem and by constructing their own knowledge in the collaborative group. Ajai, Imoko, & O'kwu (2013) also added that PBL deals with collaborative groups in which students were able to compare and evaluate their understanding of subject matter with other understanding so that it can improve their achievement.

3.2 Information Literacy

An independent t-test was conducted to compare information literacy pre-test score in the experimental and control group. Table 3 showed that there was no significant

Table 3 The Results of the detached t-test carried out regarding the difference between the pre-test scores of students' information literacy in the experimental and control group

Group	N	M	SD	SE	Detached group t-test		
					df	t	p
Experimental Group	19	27.79	14.860	3.429	37	1.228	0.227
Control Group	20	32.00	13.189				

Table 4 The results of the detached t-test carried out regarding the difference between the post-test scores of students' information literacy in the experimental and control group

Group	N	M	SD	SE	Detached group t-test		
					df	t	p
Experimental Group	19	60.84	14.860	5.022	37	-2.159	0.037
Control Group	20	50.00	13.189				

difference in information literacy scores for students in experimental group (M=27.79; SD=14.860) and students in control group (M=32.00; SD=13.189; t(37)=1.228; p=0.227, two-tailed). The 95% percent confidence interval for the difference in means ranging from -2.737 to 11.159. The non-significant result in pre-test means in both the groups had an equivalent level of achievement of information literacy.

After conducting an intervention during a month period, an independent t-test was conducted to compare students' information literacy post-test scores for students in the experimental and control group. Table 4 showed that there was a significant difference in information literacy scores for students in experimental group (M=60.84; SD=14.860) and students in control group (M=50.00; SD=13.189; t(37)= -2.159; p=0.037; two-tailed). The 95% confidence interval for the difference in means ranging from -21.017 to -0.668. The result indicates that the implementation of the Project was able to be used in improving students' information literacy.

Other results come from the information literacy in each standard. There were three standards by Montana Office of Public Instruction (2010), those are "identify the task and determine the resources needed", "locate sources, use information, and present findings", and "use information safely, ethically, and legally". As seen in Figure 8, the results of students' achievement of Information literacy in every standard were improved. For the "Identify the task and determine the resource needed" standards, the experimental group was improved by 38% and the control group was 25%. The standards of "Locate sources, use information, and present findings" for the experimental group was improved by 27% and 16% for the control group. Then, for the standards of "Use information safely, ethically, and legally" was improved 31% for the experimental group and 32% for the control group. Basically, all the standards in both groups were improved but for students who have Project in PBL has higher improvement.

The analysis of standard "Identify the task and determine the resources needed" conducted by three goals recommended by Montana Office of Public Instruction (2010), those define the problem, identify the information resources needed, and evaluate and select appropriate resources. As seen in Figure 9, every goal of the standard has improved well. The low improvement was is the goal of identifying the information and resources needed. It happened because, in this goal, students should remember about the first, second, and third source of information. Students understand its definition but still confuse in the examples of first, second, and third sources so that the improvement is still low.

The analysis standard of "locate sources, use information, and present findings" conducted by two goals

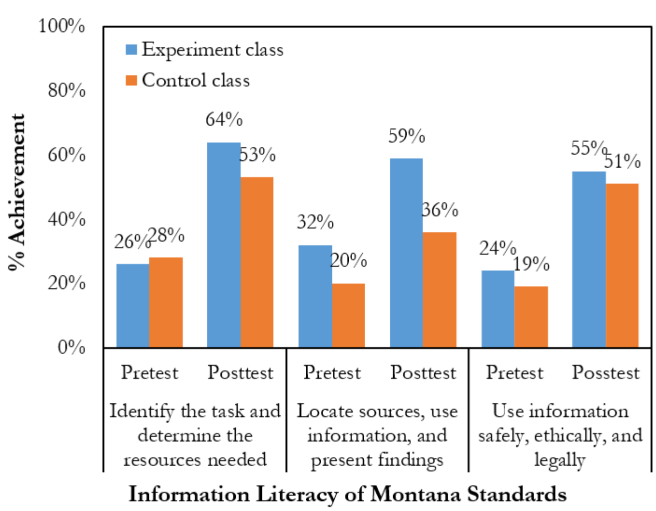

Figure 8 The students' achievement of information literacy in every standard of montana standards of public instruction

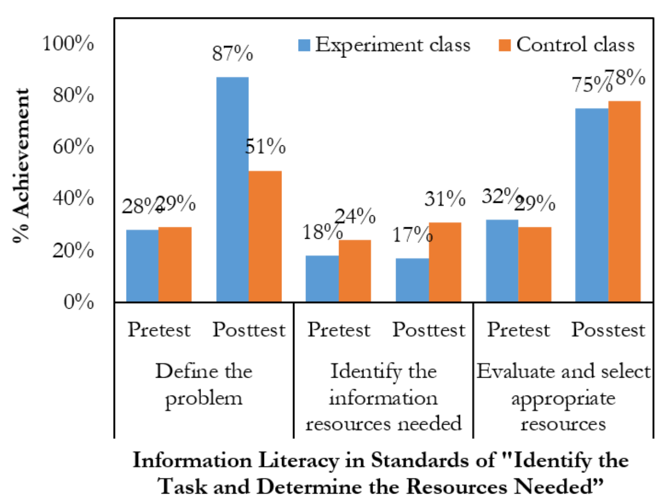

Figure 9 Profile of improvement students' information literacy in standards of "identify the task and determine the resources needed"

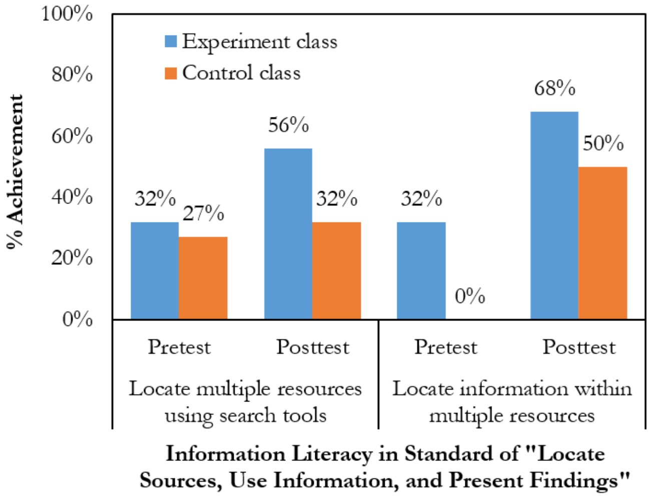

Figure 10 Profile of Improvement Students' Information Literacy in Standard of "Locate Sources, Use Information, and Present Findings"

to locate multiple resources using search tools and locate information within multiple resources. Overall, the goals of this standard have improved. As you can see in Figure 10, the improvement of the goal of locating multiple resources using search tools was 24% for the group who conduct Project and module, while the control group who got direct instruction of information has improved 5%. Another goal that locates information within multiple resources has improved students with Project and information module in 36% and the group with direct instructional information was improved by 50%. This improvement occurred because students directly practice locating the information they need to solve the problem trough exploring the various resources. This is in-line with the research finding of Wenger (2014) which stated that the PBL can help reemphasize the important aspects of information literacy by integrating information literacy into a course provided a way to actively engage students and to help students understand how the information resources fit into their assignments.

The standard of "Use information safely, ethically, and legally" consisted of three goals of (i) legally obtain, store, and disseminate text, data, images, or sounds; (ii) appropriately credits ideas and works of others; and (iii) participate and collaborate in intellectual and social networks following safe and accepted practices. Basically, all the goal has improved well as seen in Figure 10. The first goal was improved by 29% for the experimental group and 57% for the control group as seen in Figure 11. The second goal was improved by 27% for the experimental group and 2% for the control group. The third group was improved by 40% for the experimental group and 55% for the control group. The lowest improvement occurred for both groups in the second goal that is appropriately credited ideas and works of others. This happened because, in this goal, students learn about how to cite in an appropriate way

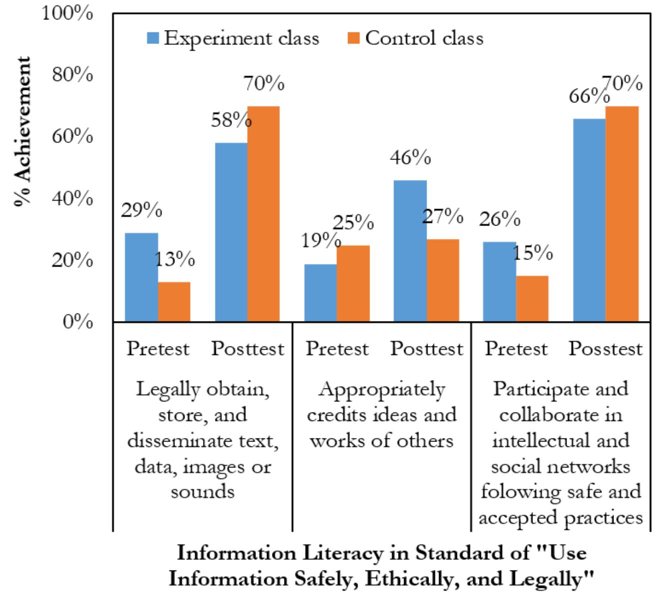

Figure 11 Profile of Improvement Students' Information Literacy in Standard of "Use Information Safely, Ethically, and Legally"

based on the right structure but confused about the structure of the reference itself. They were also not put the citation when the teacher was not asked to do so. This is a bit in line with the result finding of Shultz & Li (2016) who stated that the information literacy skills of the students are not improved through Problem-based learning and one of the reason because students were also not cited any reference in the provided worksheet when the teacher didn't ask them to do so. However, students' achievement of information literacy was improved significantly which means that the implementation of Project in PBL with the information module was able to improve students' information literacy rather than just using PBL with direct instructional information.

Improvements in information literacy aspects occurred because students should find the information about the human excretory system by themselves at the end of the class meeting. The information they gathered will be compiled in an article as the project based information. This activity encourages students to construct and make connections between their knowledge and its application in daily life. This is contradicted with the result finding of Shultz & Li (2006) who stated that the information literacy skills of the students are not improved through Problem-based learning. But, in the research of Diekema, Holliday, & Leary (2011) stated that Problem-Based Learning was an effective approach for some students by working on authentic problems, engaged deeply with information, summarize the information they found, assess its logic and validity in context, and then apply it to adapt their research strategy and create a better understanding based on their opinion. Another research by Wenger (2014) also in line with the result of the study who stated that using PBL to integrate information literacy into a course provided a way to actively engage students and to help students understand how the information resources fit into their assignments.

4. CONCLUSION

This study concluded that the Project in Problem-based learning using information module can be used to build students' scientific literacy. The achievements of scientific literacy in the domain of content knowledge, science competencies, and attitude after learning process has improved quite satisfactory, this is because Problem-based learning uses problem scenarios related to real life phenomenon to encourage students to engage themselves in the learning process by working collaboratively.

The implementation of Project in Problem-based learning using information module has also a positive effect on the students' information literacy. The achievements of information literacy in the standards of "identify the task and determine the resources needed", "locate sources, use information, and present findings", and "use information safely, ethically, and legally" has significantly improved than the group Problem-based learning with direct instructional information. Each goal in standards was also showed the satisfying improvement. This is because Problem-Based Learning working on authentic problems engaged deeply with information, summarize the information that students' found, assess its logic and validity in context, and then apply it to adapt their research strategy and create a better understanding based on their opinion. Besides, by integrating information literacy into a course, it provides a way to actively engage students and to help students understand how the information resources fit into their assignments.

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Using Brain-Based Learning to Promote Students' Concept Mastery in Learning Electric Circuit

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ABSTRACT Teaching approaches in some school are still concentrating on memorizing. Teachers have to make the learning is meaningful for the students. One of the alternative tools is by using Brain-Based Learning. The purpose of this study is to investigate the effect of Brain-Based Learning on students' concept mastery in learning electric circuit for 8th-grade students. The method used in this research was experimental research. The research design that used is pretest and posttest design. The sample was taken by random sampling in class. Participants were 49 students at one of International Secondary School in Bandung, West Java, Indonesia. Experiment group learns with Brain-Based Learning (N=26) while the control group learning with lectured based learning (N=23). The results of students' concept mastery that learned using Brain-Based Learning is better than students' concept mastery that learned using lectured-based learning. The improvement of students' concept mastery can be noticed by independent t-test with significant 0.003. Based on the analysis of students' concept mastery results, the N-Gain score in experiment group is 0.43 which categorized as a medium improvement while in the control group is 0.25 which categorized as a low improvement. Based on these results showed that Brain-Based Learning can be an alternative tool to improve students' concept mastery significantly.

Keywords Brain-based learning, Students' concept mastery, Electric circuit

1. INTRODUCTION

Currently, technological advances in the world are growing rapidly. The instructional method in school needs to adjust with the more unpredictable learning condition instead of previously (Saleh, 2012). Aziz (in Shabatat & Al-Tarawneh, 2016) stated that teaching approaches are still concentrating on memorizing. These make the students only act as a receiver of information sent by the teacher without relating to students' interest and these approaches make students' receive the information without thinking independently and processing although the students have imagination and active thinking. According to Al-Tarawneh (2016), the educators and psychologists, refinement of teaching and learning process using the neurocognitive concept to bring up Brain-Based Learning (Shabatat & Al-Tarawneh, 2016).

Dissimilar to conventional techniques of schooling, which is frequently said to restrain learning by overlooking the brain's regular learning forms, the Brain-Based Learning is accepted to support learning because of its all-encompassing methodology towards the students. It is a way to deal with realizing which supports the brain's best common operational standards, with the goal of attaining maximum attention, understanding, meaning, and memory (Jensen, 2008).

Brain-Based Learning is a student-focused and instructor encouraged methodology that uses students' intellectual gifts and accentuating important learning, it is not the only memorization. Brain-Based Learning recommends that educators must submerge students in perplexing, intuitive encounters that are both rich and genuine. Personally, the meaningful challenge can stimulate students' mind to the desired state of alertness that must have by the students (Uzezi & Jonah, 2017).

One of the important things in learning is comprehending the concept. Students' concept mastery is important that has to be gained by the students. As we know that Physics is one of the difficult subjects for junior high school students (Saleh, 2012). One of the topics in Physics of junior secondary school is an electric circuit. The

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concepts investigated include electric diagrams, current, potential difference at battery terminals, and resistance. It has been repeatedly shown that students and even teachers, make misconceptions. One of these misconceptions is the confusion between potential difference and current (Liégeois, Chasseigne, Papin, & Mullet, 2003). Evidence suggests that with the right kind of learning environment, Physics can be a valuable learning experience for the majority of students (Redis & Steinberg, 1999). There are five groups of factors that influence the level of learning achievement other than previous knowledge which has the biggest influence on learning success (Klauer, 1988). These are intellectual capability, environmental components, motivational factors, and the application of learning strategies (Klauer, 1988). One of the efforts to improve students' concept mastery is by using Brain-Based Learning approach. Teachers have to make learning is meaningful for the students because Brain-Based Learning involves accepting the rules of how the brain processes, and then organizing instruction bearing these rules in mind to achieve meaningful learning (Shabatat & Al-Tarawneh, 2016).

According to Saosa (1995) stated that a Brain-Based approach integrates the engagement of emotions, nutrition, enriched environments, music, movement, meaning-making and the absence of threat for maximum learner participation and achievement. It is a good strategy to make students' motivate in learning. Brain-Based Learning can be seen as appropriate for school students. Brain-Based Learning will make the students experiencing in the different learning environment as well as the steps is a good strategy to apply in school.

Research on Brain-Based Learning has been conducted in the past two decades (Haghighi, 2013). A previous study by Saleh (2012) it has been found and proven that Brain-Based Learning was effective in encouraging conceptual understanding towards physics among students. In another study, Brain-Based Learning was measured achievement of the female students in Chemistry subject (Shabatat & Al-Tarawneh, 2016); students' attitudes level and motivation in science class (Akyürek & Afacan, 2013); students' academic achievement and retention of knowledge in science course (Ozden & Gultekin, 2013); students' academic achievement, attitude, motivation and knowledge retention in electrochemistry (Uzezi & Jonah, 2017); and academic achievement of students with different learning styles (Duman, 2010).

Therefore, this study has investigated the difference between students' concept mastery in both control class and experimental class in learning physics, especially for electric circuit topic. There are three teaching materials about the electric circuit, which are the circuit component, series circuit, and parallel circuit. The aim of this study is to investigate the effect of Brain-Based Learning on students' concept mastery in learning the electric circuit.

Table 1 Experiment design

Control Class	Pre-test	Lectured-based Learning	Post-test
Experimental Class	Pre-test	Brain-based Learning	Post-test

Table 2 Data of the sample

Group	Population	Sample	N	Percentage (%)	Total (%)
Control	8th grade	Male	13	56.52	100
		Female	10	43.48	
Experiment	8th grade	Male	15	57.70	100
		Female	11	42.30	

2. METHOD

The research method which was used in this study is quasi-experiment. Quasi-experiments include assignment, but not a random assignment of participants to groups (Creswell, 2012). The experiment design is shown in Table 1.

The location of this research was held in one of International secondary school in Bandung, West Java, Indonesia. The school used the Cambridge curriculum. The population in this research was 8th-grade students. The samples are 8th-grade students from two different classes in international secondary school in Bandung. Students in both groups come from similar educational and socio-economic backgrounds. Their ages ranged between 13-14 years old. The sampling technique was Cluster Random in Class. Fraenkel, Wallen, & Hyun (2012) stated that cluster random sampling is defined where one is obtained by using groups as the sampling unit rather than individuals. The data of the sample can be seen in Table 2.

In this study, the topic of the electric circuit is limited based on IGCSE Physics syllabus for secondary students. The subtopics that investigated are (1) Circuit component, (2) Series circuit, (3) Parallel circuit. The experimental group was given Brain-Based Learning. According to Saosa (1995), there are seven steps to conduct Brain-Based Learning which are activation means to activate the students prior knowledge, clarification means clarify the objective and students have their personal performance target, making the connection means they connect their previous understanding with the new information, doing the learning activity means the students are digesting, thinking about, and experiencing multisensory, demonstration of student understanding means the students are in brain active-processing, review of student recall and retention means the students strengthen the transfer process and summarize the knowledge or information, and previewing the new topic means the students are prepared for the new topic. While the control group followed the Lectured-Based Learning that includes lecturing and discussion.

Students' concept mastery from both groups was measured before and after the intervention to determine the effectiveness of the implemented Brain-Based Learning. The research was done in five meetings. The first meeting was for pre-test, the second meeting was for circuit component subtopic, the third meeting was for series and parallel subtopic, the fourth meeting was for practical action, and the fifth meeting was for post-test. Students' concept mastery was measured using an objective test of 20 multiple choice questions which consists the cognitive level C1 (remembering), C2 (understanding), C3 (applying), and C4 (analyzing) based on Bloom Taxonomy (Anderson and Krathwohl, 2001). All of the test items were analyzed in the process of judgment from the expert and tested to the students. The result of the test items after the process of judgment will be used, revised, or either deleted. The objective test analyzed using ANATES. The reliability score is 0.78 which is high reliability.

3. RESULT AND DISCUSSION

The results show quantitative data. The pre-test and the post-test are conducted to determine the students' concept mastery before and after treatment.

3.1 Implementation of Brain-Based Learning

The research was done in five meetings. The first meeting and last meeting was fore pretest and posttest. In this research, experiment class was treated learn with Brain-Based Learning, while the control class was treated learned with lectured based learning. The research was done in one of International Junior High School in Bandung in April 2018 with the samples students from 8th-grade in two classes. The instructional process was done in three meetings with the duration in each meeting was 70 minutes. Both the control group and experiment group have the same duration. The pretest was held on April 11th, 2018 and posttest was held on April 25th, 2018. The implementation of Brain-Based Learning was investigated by observation sheet during the lesson. The percentage of Brain-Based Learning implementation is presented in Table 3.

According to Table 3 above about the percentage of Brain-Based Learning implementation, teacher and students implemented or done all activities that have been determined in the lesson plan. The average implementation percentage is 100% which according to Arikunto (2013) is categorized as very good. The result of Table 3 will be elaborated in the following explanation.

First Treatment

The first treatment was held on April 12th, 2018 in control group while in the experiment group was held on April 13th, 2018. Both groups learned circuit component subtopic. The main difference as general from both group shown in Table 4

At first, the teacher relates the previous topic about current and the topic that they would learn which was about circuit component by showing them a picture of an electric circuit including circuit component. The teacher stated the learning objectives of the lesson and showed the mind map to the students so that the students can develop new knowledge and the teacher gave instruction to do brain gym. All students were joined.

The main activity began, the teacher showed the picture of the circuit component as shown in powerpoint and the students have to predict. They also discussed how the lamp can be turned on/off. The students were given the worksheet and they work with their partner. They had to discuss the difference of closed circuit and open circuit and predict the function of a circuit component in the worksheet. After that, the students discussed in their Kagan's group (a group that has arranged by the school). There was six groups. One of the group was asked to presents the results of discussion and teacher clarified the answer and gave then question example.

The next activity was demonstrating understanding, the students played the game. Each group would have one card. In the card, there are questions about draw the electrical circuit based on the circuit component provided in the questions. All the students were excited because the reward was offered to the group that has the best score. While they were doing their mission, the teacher sets the time so it would be more challenging and classical music was played.

The next activity, the students swap their answer to another student. The answer is shown on the board, the representative of the students wrote it on the board and teacher clarify the answer using colorful board marker. In the end, the teacher reviews the activity and the lesson by asking some questions to the students. Rewards were given to the group that has the best score. There are three groups

Table 3 Percentage of Brain-Based Learning implementation

Meeting	Topic	Percentage of Implementation	Criteria
1	Circuit Component	100%	All activities implemented
2	Series Circuit	100%	
3	Parallel Circuit	100%	

Table 4 Student activities in the first treatment

Class	Description of Activities	
Experiment	Start	Students are shown mind map about circuit component and did brain gym.
	Main	Students did discussion and exercise in the group when the music is played.
	Close	Teacher review the lesson and give the reward.
Control	Start	Students are shown learning objectives of learning circuit component.
	Main	Students did discussion and exercise in group.
	Close	Teacher review the lesson.

Table 5 Student activities in second treatment

Class	Description of Activities	
Experiment	Start	Students are shown mind map about series and parallel circuit and do brain gym.
	Main	Students did discussion and exercise in the group when the music is played.
	Close	Teacher review the lesson and give the reward.
Control	Start	Students are shown learning objectives about series and parallel circuit.
	Main	Students did discussion and exercise in group.
	Close	Teacher review the lesson.

that have the same score. The teacher asked students to prepare the next lesson about series and parallel circuit.

Second Treatment

The second treatment was held on April 18th, 2018 in both control group and experiment group. Both groups learned series and parallel circuit subtopic. The main difference as general from both group shown in Table 5.

At first, the teacher relates the previous topic about circuit component and the topic that they would learn which was about series and parallel circuit by showing them a picture of series an parallel circuit. The teacher stated the learning objectives of the lesson and showed the mind map to the students so that the students can develop new knowledge and the teacher gave instruction to do brain gym. All students were joined.

The main activity was begun, the teacher showed the picture of series and parallel circuit as shown in powerpoint and the students have to predict what is the difference between both circuits. One of the students shared the answer. The students were given the worksheet and they work with their partner. They had to discuss the difference of voltage, current, and resistance in series and parallel circuit in their worksheet with a partner. After that, the students discussed in their Kagan's group (a group that has arranged by the school). There was six groups. One of the group was asked to presents the results of discussion and teacher clarified the answer and gave them question example.

The next activity was demonstrating understanding, the students played the game. Each group would have one card. In the card, there are questions about identifying series and parallel circuit. The questions relate also about current, voltage, and resistance. All the students were excited because the reward was offered to the group that has the best score. While they were doing their mission, the teacher sets the time so it would be more challenging and classical music was played. Some of the group looked hard to answer the question and need more time but in the end, they can do the question.

The next activity, the students swap their answer to another student. The answer is shown on the board, the representative of the students wrote it on the board and teacher clarify the answer using colorful board marker. In the end, the teacher reviews the activity and the lesson by asking some questions to the students and conclude the lesson. Rewards were given to the group that has the best score. There are two groups that have the same score. The teacher asked students to prepare the next lesson about the practical activity of series and parallel circuit.

Table 6 Student activities in third treatment

Class	Description of Activities	
Experiment	Start	Students are shown mind map about the practical activity and do brain gym
	Main	Students did discussion and exercise in the group when the music is played.
	Close	Teacher review the lesson and give the reward.
Control	Start	Students are shown learning objectives
	Main	Students did discussion and exercise in group.
	Close	Teacher review the lesson.

Third Treatment

The third treatment was held on April 19th, 2018 in control group while in the experiment group was held on April 20th, 2018. Both groups did the practical activity of series and parallel circuit. The main difference as general from both group shown in Table 6

At first, the teacher relates the previous topic about series and a parallel circuit including some formula and the topic that they would learn which was about the practical activity of series and parallel circuit by showing them some tools of the activity. The teacher stated the learning objectives of the lesson and showed the mind map to the students so that the students can develop new knowledge and the teacher gave instruction to do brain gym. All students were joined but some of them looked more enthusiastic to do the activity.

The main activity began, the teacher showed the PhET (Physics Education Technology) simulation to the students and they have to predict which circuit would have greater current and greater resistance, and also vice versa. They were shown PhET simulation so that they can predict the result of the activity that they would do. One of the students shared the answer. The students were given the worksheet and they work with their group. All of the group make the series and parallel circuit based on the question on the worksheet. The students discussed in the group about the results of ammeter reading, voltmeter reading, and the rheostat affecting the current. One of the group was asked to presents the results of discussion and teacher clarified the answer and gave them question example related to current, voltage, and resistance.

The next activity was demonstrating understanding, the students played the game. Each group would have one card. In the card, there are questions about identifying and

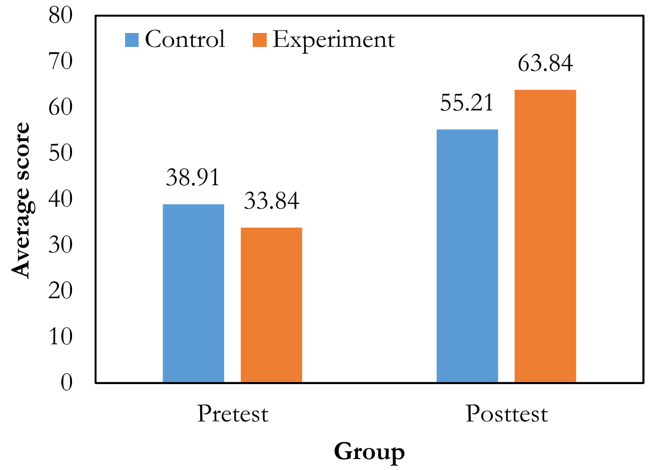

Figure 1 Average score in experiment and control group

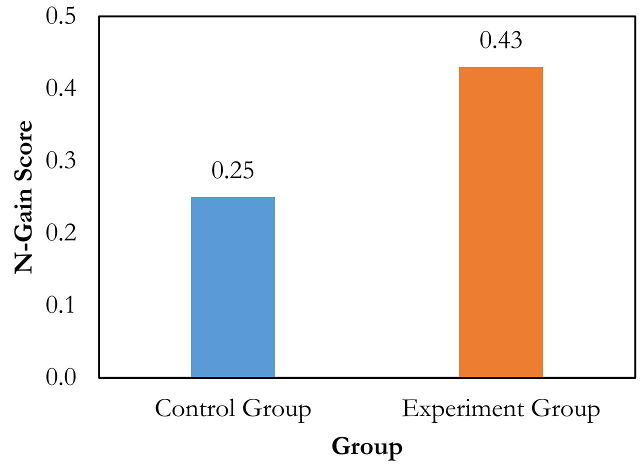

Figure 2 N-Gain score in experiment and control

calculating the voltage, current, resistance in series and a parallel circuit (lamp and resistor). All the students were excited because the reward was offered to the group that has the best score. While they were doing their mission, the teacher sets the time so it would be more challenging and classical music was played. It is not too conducive since some of the students were playing with the tools, the teacher keeps remind the students not to play with the tools.

The next activity, the students swap their answer to another group. The answer is shown on the board, the representative of the students wrote it on the board and teacher clarify the answer using colorful board marker. In the end, the teacher reviews the activity and the lesson by asking some questions to the students and conclude the lesson. Rewards were given to the group that has the best score. There are two groups that have the same score. The teacher asked students to prepare the next meeting which is posttest.

Table 7 Recapitulation of hypothesis test on students' concept mastery

Hypothesis Test			Result
Normality Test			
	Experiment class	Signification (sig.α = 0.05)	0.315
		Conclusion	Normally Distributed
	Control class	Signification (sig.α = 0.05)	0.819
		Conclusion	Normally Distributed
Homogeneity Test			
		Signification (sig.α = 0.05)	0.332
		Conclusion	Homogenous
Independent t-Test			
		Signification (sig.α = 0.05)	0.003 (Asymp. Sig.(*2-tailes*) < 0.05, H_1 = Accepted)
		Conclusion	H_1 = accepted, H_0= rejected There is a significant difference

3.2 Students' Concept Mastery

The results of pretest and posttest score were calculated and the data were analyzed using SPSS version 20 to know whether the data is normally distributed or not. Then, the data is analyzed using a parametric or non-parametric test based on the result of the normality test. The statistic test was done in order to know the difference of concept mastery between control and experiment group. The recapitulation of the statistical test result of control and experiment group is shown in Table 7.

From the results in the Shapiro-Wilk test, the significance value (α) on the control group is 0.819 and 0.315 for experiment group. If compared with the value of α result in sig. > α = 5% then H_0 is accepted which means that the data on the control group and experiment group are normally distributed. Then, continue to homogeneity test. Based on the results of Levene Statistics test, the result of the homogeneity test is 0.332 so if compared with α, resulting in 0.332 > α = 5%, then the data are homogeneous. Since the data is normally distributed and homogenous, then continue with a parametric test which is Independent-Samples T-Test.

The level of significant value used in the test is 0.05. The results of the test show that the significant value is 0.003 or less than 0.05, it means that there is the difference in students' concept mastery in learning electric circuit after using Brain-Based Learning (BBL) or there is a significant effect. The average score of students' concept mastery in pretest and posttest is shown in Figure 1.

Based on Figure 1 it can be found that the average of pretest score in the control group was 38.91 and for the experiment, the group was 33.84. While the average of posttest score in control and experiment group was 55.21 and 63.84. It means there is an improvement on students' concept mastery in learning electric circuit after the treatment. It can be concluded that students from the

Table 8 Pretest and posttest for each cognitive domain

Group	Aspect	Cognitive level score			
		C1	C2	C3	C4
Experiment	Pretest	69.23	34.61	30.77	27.88
	Posttest	80.76	53.84	65.38	83.65
	G	11.53	19.23	34.61	55.76
	<g>	0.12	0.22	0.45	0.75
	Category	Low	Low	Medium	High
Control	Pretest	52.17	36.95	41.73	34.78
	Posttest	95.65	50.43	54.78	55.43
	G	43.47	13.47	13.04	20.65
	<g>	0.43	0.18	0.06	0.29
	Category	Medium	Low	Low	Low

experiment group that learned using Brain-Based Learning have a difference in improvement of learning outcomes than the control group in learning the electric circuit. The difference between N-Gain for experiment group and the control group can be seen in Figure 2.

The analysis of N-Gain on control group and experiment group shows that the treatment gives the impact on the improvement of students' concept mastery in learning the electric circuit. The N-Gain score from control group is 0.25 which is categorized as a low improvement while the experiment group got 0.43 which is categorized as a medium improvement (Hake, 1999).

3.3 Students' Cognitive Domain

Data continued analyzed from the average of N-Gain from C1, C2, C3, and C4 in both groups. To know the improvement of students understanding in each level, test of N-Gain was done by first grouping the questions based on its cognitive level. Then, find the average of pretest and posttest score, and after that calculating the N-Gain from the control group and experiment group. The results of pretest and posttest for each cognitive dimension in each group is shown in Table 8.

From Table 8, it can be seen that each cognitive domain shows different results of students' concept mastery either in pretest and posttest. In the control group shows that the average N-Gain on remembering (C1) is 0.43 which is categorized as a medium. The average of N-Gain on understanding (C2) is 0.18 which is categorized as low. The average of N-Gain on applying (C3) is 0.06 which is categorized as low, and the average of N-Gain on analyzing (C4) is 0.29 which is categorized as low.

The results in the experiment group show that the average N-Gain on remembering (C1) is 0.12 which is categorized as low. The average of N-Gain on understanding (C2) is 0.22 which is categorized as low. The average of N-Gain on applying (C3) is 0.45 which is categorized as a medium, and the average of N-Gain on analyzing (C4) is 0.75 which is categorized as high. It can be concluded from, in the experimental group has higher improvement in the C4 domain while in control group has higher improvement on C1 domain. Based on the results, the data can support that the fact that students in the experiment group can more comprehend the topic than in the control group. The improvement for each cognitive level is presented in Figure 3.

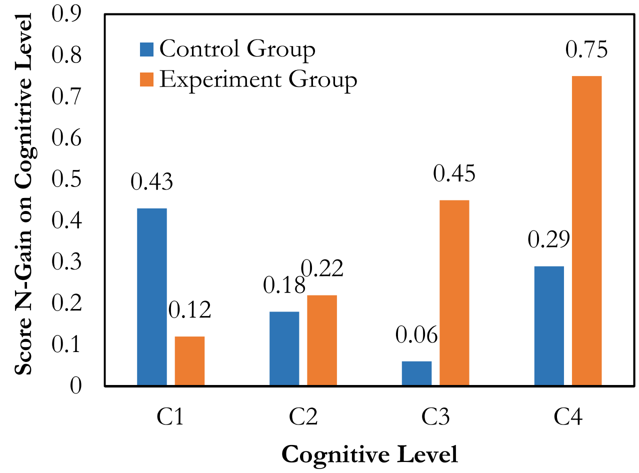

Figure 3 Comparison of the cognitive level of blooms' taxonomy between experiment and control group

According to Figure 4.3, we can see that generally, the experimental group got higher N-Gain in cognitive domain C2 (understanding) is 0.22, C3 (applying) is 0.45, and C4 (analyzing) is 0.75. However, for domain C1 (remembering), control group got higher N-Gain because for the control group in the pretest they got a lower score than experiment group. Most of the students in experiment group answered correctly for domain C1 (remembering) in the pretest so that the N-Gain for domain C1 (remembering) is 0.12 which is lower than a control group that got 0.43.

In C2 (understanding) domain, the experimental group got higher N-Gain than control group although both of them categorized as a low improvement. The low gain was obtained because most of the questions in the test are C2 (understanding) domain. This can be one of the factors because the number of the question if more than other domain.

In C3 (applying) domain, the experiment group got higher N-Gain than the control group. In the question are mostly about the picture of series and a parallel circuit including ammeter and voltmeter. Although both of the group were exercised about this question, in experiment group, they showed PhET simulation and practical activity so that it is easier to understand and more interesting while in control group they only experienced in practical activity.

In C4 (analyzing) domain, experiment group got higher N-Gain than the control group. The questions are mostly provided a picture of series and parallel circuit. Only one question requires calculation. The experiment group got higher N-Gain because the students in the class were paying attention compared to the control group. In the control group, not all the students paying attention when the teacher explained this type of question. The questions would be easy if they have known the concept.

The cognitive domain result can show that the use of Brain-Based Learning can improve students' ability in all cognitive domain level that was measured. The researchers attributed this result to the benefits of using the Brain-Based Learning that was summarized by Caine & Caine (1997) and Jensen (2012). The strategies harmonized with principles, such as work in groups, encourage cooperation among students, indicate that teaching process will be more efficient when it is conducted within a teaching environment that provides students with chances to exchange experiences within collaboration groups. The use of concept charts which leads to link the major and minor themes together, and organize the knowledge hierarchically makes learners more capable to use, retain the knowledge easily. The note writing (taking notes) help in memorizing the written material. Marshall (2002) and Obeidat and Abussameed (2013) emphasize that taking notes helps knowledge memorization, retrieving, developing, enhancing with more information. Taking notes also make new relations between previous and new knowledge. The use of brainstorming helps in generating creative ideas by encountering a new situation and problem by the students. The review of the previous lesson is important to these strategies whether work in groups, concept charts, notes taking, and brainstorming activates the previous information in the brain. Jensen (2008) discovered that information is not static so it needs frequent review and repetition, else it will be lost or leaked. These skills need more time to apply.

The positive impact is seen by the application of several strategies especially on increasing the interaction of students to the class situations. By applying varied activities and techniques can meet the needs and interests of students and take into account the individual differences, it also helps more relaxation, active processing and improves achievement (Aljorani, 2008).

Another difference between experiment group and control group is brain gym. Brain Gym facilitates the process of waking up the mind/body system, and learning readiness. Through simple integrative movements that focus on specific sensory aspects, Brain Gym activates the full mind/body function across the body midline (Klinek & Indiana, 2009)

The improving of students' concept mastery that has been found is in line with the research done by Saleh (2012) which found that Brain-Based Teaching Approach was more effective in developing students' conceptual understanding as compared to the conventional method. It is also in line with other research by Shabatat & Al-Tarawneh (2016) which found the level of achievement has been improved by using Brain-Based Learning.

Furthermore, the students who learned with Brain-Based Learning tend more active in class especially when they had to discuss in a group. They were encouraged with a challenging environment and rewards. This is in line with the finding from Shabatat & Al-Tarawneh (2016) that based on the results, the researchers found the benefits of using Brain-Based method and principles which are the students work in groups, encourage cooperation among students, environmental support that provides students with chances to exchange experience within collaboration groups. This result in line with a previous study (Ozden & Gultekin, 2013) that Brain-Based Learning approach appears to be more effective than the traditional teaching procedures in science courses in terms of improving students' academic achievement.

Another difference between experiment group and control group was the utilization of mind map. The experiment group was shown mind map at the beginning of the lesson, it is helpful to improve the achievement of students. This result in line with finding from Jbeili (2013) that using digital mind maps had a significant effect on students' science achievement. The implementation of inquiry activities in experiment group also in line with finding from Wardani (2017) that inquiry-based laboratory activity can improve students' understanding.

4. CONCLUSION

Brain-Based Learning can improve students' concept mastery on electric circuit topic. It can be proved by the acceptance of H_1 and the result of significance is 0.003 which means that there is a significant difference in learning using Brain-Based Learning on students' concept mastery. The improvement also supported by the results of N-Gain in experiment group is 0.43 which is categorized as medium improvement and N-Gain in control group is 0.25 which is categorized as a low improvement. It can be concluded also that Brain-Based Learning improved students' concept mastery in all cognitive level. Brain-Based Learning can be one of the alternative teaching approaches that can improve students' concept mastery in learning the electric circuit.

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Enhancing Students' Creativity through STEM Project-Based Learning

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ABSTRACT In some school, teacher-centered is commonly found in the learning process. The learning process itself is still in the form of direct transfer of knowledge from teacher to students. Actually, students will learn better if they are engaged in a meaningful learning activity. STEM project-based learning is one of the alternative teaching strategies that engaged students in meaningful learning. The aim of this study is to investigate the impact of STEM project-based learning on students' creativity in the topics of light and optics. The study used qualitative research with the narrative design. Data collection technique that used is observation. The population is eight grade students in one of Junior Secondary School that is located in Bandung, Indonesia. The sample consists of 25 students that chosen based on purposive sampling technique. The data is obtained through Creativity Product Analysis Matrix (CPAM). There are three creativity dimensions that used in this study which are resolution, elaboration and novelty dimension. Students' creativity is obtained as much 76% which categorized as good. Based on the result, STEM project-based learning give a good impact on students' creativity. STEM project-based learning can be used as alternative teaching strategies in Junior Secondary School.

Keywords STEM Project-based learning, Students' creativity, Light and optics

1. INTRODUCTION

The advance of technology can produce competition in several life aspects, especially in education. The competition makes some countries change their education system and strategies that involving technology in the learning process. The use of technology in the learning process can be seen in the utilization of technology in making students' project. Students are more excited when making a project that involves the technology by constructing the power point which includes the byte, video clips, picture, text, and animation in the slide. Students identified that working with technology is easier and possible for students to work quickly and efficiently (Heafner, 2004).

Regarding that technology is important in this modern era, the education system should prepare students with the skills that need in facing the advance of technology. The students' skills in Indonesia do not really satisfy the skills needed in facing the advance of technology if the learning process only based on teacher-centered. In some school, teacher-centered is commonly found in the learning process. The learning process itself is still in the form of direct transfer of knowledge from teacher to students. Students will learn better if they are engaged in meaningful learning activity (Fortus et al., 2005).

Science, Technology, Engineering and Mathematics (STEM) education has potential to improves the quality of education. STEM education integrates the contents and skills with science, technology, engineering, and mathematics. Therefore, Asmuniv (2015) stated that STEM education can improve the quality of human resource with interdisciplinary in preparing students career. STEM gives an opportunity for students to understand real-world problems based on those interdisciplinary subjects (Dugger, 2010). Interdisciplinary STEM aims to emphasize the importance of 21-century skill development such as adaptation skill, social skill, communication skill, problem-solving skill, and self-development (Bybee, 2010).

Science (S) explains the existence of objects and events, the laws and principle of these objects and events, and the relationship between them (Capraro, Capraro, & Morgan, 2013). Technology is an innovation and modification of natural environment to produces things that needed and

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desired by a human (Dugger, 2010). Technology (T) maybe e-books, or online encyclopaedia which gives students direct access to find any information or sources; probes, sensors and experiments sets that enable students to collect data; social networking or websites that enables students access or contact the experts via online communication tools; presentation or video editing software that facilitate students in making presentation; and recording or analysis software that enables students to extend their capabilities (Bruce & Levin, 1997). Engineering (E) is research and development based on science in order to manufacture certain products to solve problems (Capraro, Capraro, & Morgan, 2013). Engineering in STEM project-based learning can be called the design process. Mathematics (M) defined as an abstract representational system used in the study of numbers, shape, structure and change, and the relationship between these concepts (Capraro, Capraro, & Morgan, 2013).

Several studies have been observed about the STEM field in some cases. Previous studies have been measured pre-service science teachers interest in STEM career by interest survey (Winarno, Widodo, Rusdiana, Rochintaniawati, & Afifah, 2017); the attitude of pre-service science teacher regarding STEM area (Winarno et al., 2018); students' problem-solving skill and students' creativity based on girls' interest in STEM subject field (Cooper & Heaverlo, 2013); students' STEM literacy by conducting STEM learning using Arduino-Android Game (Yasin, Prima, & Sholihin, 2018); and students' science process skills, students' science concept and students' science content knowledge for gifted elementary students in the involvement of STEM (Robinson, Dailey, Hughes, & Cotabish, 2014).

STEM project-based learning is one of learning model that can be used to satisfy the needs of STEM education and prepare students in facing the advance of technology. STEM project-based learning is the project-based model that integrate Science, Technology, Engineering and Mathematics (STEM) in curriculum design (Lou, Tsai, & Tseng, 2011). The design process and interdisciplinary of instruction make STEM project-based learning is unique. The design process of STEM project-based learning starts with preparing well-defined outcome by setting the objective and planning the summative assessment of the project. Then, students will be given the ill-defined task that expresses their ideas to solve a complex problem with a different solution (Capraro, Capraro, & Morgan, 2013).

Based on the study of Lou, Chou, Shih, & Chung (2017), there are 5 stages of STEM project-based learning that can be adopted for the teacher. The stage of preparation is guiding students to understand the theme, scope, and problem. The stage of implementation required students to produce a project according to their design drawings and conducted the actual test. The stage of presentation is requiring students to present the project result. The stage of evaluation required the teacher to gives the evaluation or suggestion regarding students' project. The stage of correction was encouraged students to make the correction according to the evaluation.

Creativity is one of 21st-century skill that needed by students in facing the advance of technology and preparing their future career. Based on teacher interview, there still many teachers who measure the cognitive aspects. From this case, there is an indication that students have a lack of skills, especially in creativity. Teachers have not trained students to strengthen their creativity. Even though, the curriculum that was developed is more emphasized in the creativity aspect. Creativity is one of important skill that should be fostered by students (Dawes & Wegerif, 2004). Creativity refers to the creation of a novel and appropriate response, product, or solution to an open-ended task (Amabile, 2012). If the creativity relates to the learning and technology it will produce a high quality of work. In the recent study show that technology allows the students to construct several media that can help them to produce high quality of work in the creativity context (Loveless, 2002). STEM project-based learning has a chance to give a positive impact in creativity because students will develop their own idea to create the product.

Various studies have been proved that STEM project-based learning gives effects in several aspects. STEM project-based learning has been measured students' creativity in aspects of adventurousness, curiosity, imagination and challenge (Lou, Chou, Shih, & Chung, 2017); Students' learning attitude through multi-function electric vehicle (Tseng, Chang, Lou, & Chen, 2013); Students' science achievement through the implementation of latent growth modelling (Erdogan & Capraro, 2016); Students' imagination and STEM knowledge development for female high school students (Lou, Tsai, Tseng, & Shih, 2014); Academic achievement for high, middle, and low achievers (Han, Capraro, & Capraro, 2014); and perception of pre-service and in-service teachers regarding the implementation of STEM project-based learning in science class (Siew, Amir, & Chong, 2015).

Students creativity through STEM project-based learning has been conducted in the previous study. The previous study investigated four dimensions of creativity in aspects of adventurousness, curiosity, imagination and challenge in the concept of density, buoyancy, fluid, heat transfer and thermal energy (Lou, Chou, Shih, & Chung, 2017). For further identification, this study will investigate students creativity with another three dimensions of creativity. The three dimensions of creativity that used are resolution, elaboration, and novelty, while the concept that was chosen is light and optics. Therefore, the aims of this study are to investigate the effect of STEM project-based learning on students' creativity in the concept of light and optics.

Table 1 Population and sample

Population	Sample	N	Percentage (%)	Total (%)
8th Grade Students	Male	13	52	100
	Female	12	48	

2. METHOD

2.1 Research Method

The study used qualitative research with the narrative design. Narrative research designs are one of the qualitative procedures where researcher describes the things that happened during class, then collects and explains stories about students' lives and experience in the form of narratives (Creswell, 2012). Data collection technique that used is observation. In collecting data, the researcher has a role as non-participant in the study. In non-participant observation study, the researcher only watches and observe the activities in the class and not directly involves in the observed situation.

2.2 Population and Sample

This study is conducted in one of Junior Secondary School that is located in Bandung, Indonesia. *Kurikulum 2013* is implemented as the curriculum in this school. The population of this study is 8th-grade students between 14 until 16 years old. About 25 students that consist of 13 males and 12 females are selected as sample. The sampling technique that used was purposive sampling which requires the researcher to uses a personal judgment and believes to choose the samples (Fraenkel, Wallen, & Hyun, 2012). 8th-grade students in this school are categorized as the high, medium and low achievement. Thus, researcher considered sample who have the medium achievement. The sample and population are represented in Table 1.

2.3 Research Instrument

The research instrument was used to collect the data needed in this study. Research instrument that used is creativity product analysis matrix (CPAM) that was developed by Besemer and Treffinger (1981). The data that was collected from students' creativity is based on a creative product that was made by students during STEM project-based learning activity. The students' creativity is scored by 1 until 3 scales for each criterion of creativity. The criterion that used is valuable, useful, well-crafted, expressive, original and novelty. The creativity product analysis matrix (CPAM) can be shown in Table 2.

Table 2 Instrument for creative product analysis matrix (CPAM)

Creative Dimension	Criterion	Score 1	Score 2	Score 3
Novelty	Germinal	The lower level of germinal: The product is inspiring others with the creation	Medium level of germinal: The product is inspiring others to try something new	High level of germinal: The product is inspiring others to try something new by directly give ideas to develop more product design
	Original	The lower level of originality: Students mostly use the previous finding as their product idea	Medium level of originality: Students use the previous finding as their idea, but they make a modification of the product	High level of originality: The product idea comes from their own understanding
Resolution	Valuable	The lower level of Valuable: The product is not compatible with the purpose and not relates to the concept	Medium level of Valuable: The product is compatible with the purpose and not relates to the concept	High level of Valuable: The product is compatible with the purpose and relates to the concept
	Useful	The lower level of Usefulness: The product can be used once	Medium level of Usefulness: The product can be used continuously with a certain requirement	High level of Usefulness: The product can be used continuously without any requirement
Elaboration	Well Crafted	The lower level of Well Crafted: The product is done well	Medium level of Well Crafted: The product is done well with the good looking design	High level of Well Crafted: Students take an effort to give interesting product design by using some materials
	Expressive	The lower level of expressive: The product is presented with lacking body language and need to control speaking tone, not understandable	Medium level of expressive: The product is presented with lacking body language and need control speaking tone, but understandable	High level of expressive: The product is presented in a communicative way (using effective body language and clear voice) and understandable manner

Table 3 The activities of STEM project-based learning for each stage

Meeting	Stage	Activity
1st	Preparation	Students recognize the project theme and scope
		Students find the information from the internet regarding the basic concept in making project
		Students discuss tools and materials that will be used
		Students produce design drawing
2nd	Implementation	Students make the project based on the design drawing
		Students conduct an actual test of their product
3rd	Presentation	Each group present their product and basic concept behind the product
	Evaluation	Teacher gives an evaluation regarding students' product
		Students conduct peer evaluation regarding another groups' product
4th	Correction	Students make self-correction about the product according to suggestion and feedback

2.4 Research Procedure

The stages used in this study consist of preparation, implementation, presentation, evaluation, and correction (Lou, Chou, Shih, & Chung, 2017). This study needs fourth meeting to finish all stages of STEM project-based learning, i.e. (1) First meeting, researcher conducted preparation stage which leads students to understand the theme and scope, (3) Second meeting, researcher conducted implementation stage which let students to create the product based on their design drawing, (4) Third meeting, researcher conducted presentation and evaluation stage that give opportunities for other to give suggestion regarding the project that are presented, and (5) Fourth meeting, researcher conducted correction stage which give students opportunity to improve their product. The learning activities of each stage STEM Project-based learning can be represented in Table 3.

3. RESULT AND DISCUSSION

The implementation of STEM project-based learning is related to the integration of Science (S), Technology (T), Engineering (E), and Mathematics (M). In this study, students will make the mini projector based on the STEM field. The integration of STEM in making mini projector activities can be presented in Table 4.

Science (S) field in this study discusses the concept of the image that was formed in the lens. Before making the mini projector, students should recognize how is the image formation in both of convex lens and concave lens. If students already understand about the characteristic of the image, they are able to decide the proper lens that used in constructing the mini projector. In this concept, students were expected to determine the correct length or room of lens, so the mini projector will produce a real and enlarged image. Technology (T) field in this study can be sawed in preparation stage when students used the internet to find any information that was needed in making a mini projector. Furthermore, students should make their decision to select the suitable tools and materials. Technology (T) field also can be found in the implementation stage when students conducted the actual test, this activity requires students to check whether their mini projector is worked or not. Engineering (E) in this study can be observed in the preparation stage when students made their own design drawing. Design drawing that was made by students should be suitable with the concept of image formation in the lens. In order to make students easier to construct the mini projector, students were expected to put detail information in their design drawing, such as focal length, type of lens and distance of the object. Mathematics (M) in this study refers to the magnification of image that was produced by the mini projector. Students apply the formula to calculate the magnification of a mini projector.

Table 4 The integration of STEM in making the mini projector

Science (S)	Technology (T)	Engineering (E)	Mathematics (M)
The formation of Image in Lens	Find Information from the Internet Decide the tools and materials Conduct an Actual Test	Design Drawing	Magnification Calculation

The result shows the qualitative data that was obtained based on creativity rubric. Students' creativity measured based on students' product which is making a simple projector. The students' creativity is assessed by using the Creative Product Analysis Matrix (CPAM) that adapted from Besemer and Treffinger (1981). CPAM is grouped into three creative dimensions which are resolution, elaboration, and novelty. The data is obtained based on the criterion of each creativity dimension. Each criterion is scored with a rubric scale from 1 until 3 based on several requirements.

Creativity is the creation of a novel and appropriate response, product, or solution to an open-ended task (Amabile, 2012). Two criteria have been selected for each three dimensions of creativity based on Besemer and Treffinger (1981). Useful and Valuable criteria have been selected for the resolution dimension. Valuable Criteria

Table 5 Creative product analysis matrix (CPAM) rubric

Creative Product Criteria	Criterion	Group 1			Group 2			Group 3			Group 4			Group 5		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Novelty	Germinal		√		√					√		√		√		
	Original		√		√					√		√			√	
Resolution	Valuable			√	√					√			√		√	
	Useful		√			√				√		√			√	
Elaboration	Well Crafted			√	√					√			√			√
	Expressive			√			√		√				√		√	

Table 6 Students' creativity result

Creativity Dimension			Ave-rage	Cate-gory
Resolution	Elaboration	Novelty		
77%	87%	63%	76%	Good

refers to how the product is judged worthy by others because the product fills the financial, physical, social, and psychological needs by the judgment, while Useful Criteria refers to how the product has clear and meet the practical application. Then, Well-crafted and Expressive criteria have been selected for elaboration dimension. Well-crafted Criteria refers to how the product appears and has been worked or reworked with care which idea developed, while Expressive Criteria defined as how should the product is presented with the communicative way and understandable manner. For the last, Germinal and Original Criteria was chosen for novelty dimension. Germinal Criteria defined as the product is likely to suggest an additional for the future creative product, while Original Criteria is how the product is unusual and rare to find with the same product idea in a similar experience.

The result is obtained based on the criterion of each creativity dimension. Each criterion is scored with a rubric scale from 1 until 3 based on several requirements. The creative rubric of CPAM is presented in Table 5.

All criteria of each creativity dimension are used to assess a student's project product after implementing STEM project-based learning. The recapitulation of students' creativity in this study can be seen in Table 6.

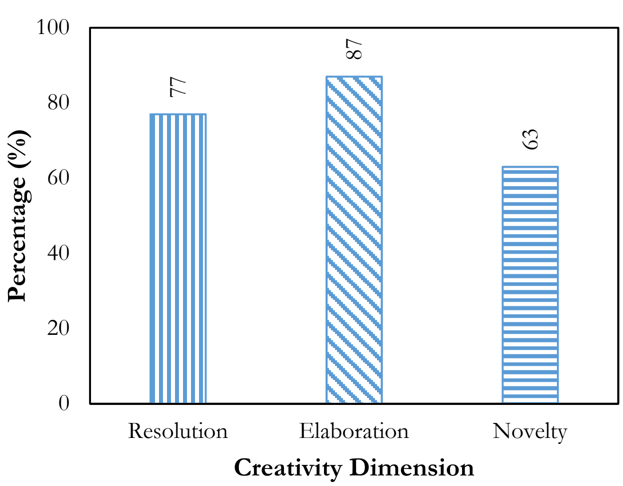

Figure 1 Students creativity for each dimension

The result is shown that each creativity dimension has different attainment. resolution dimension obtained 77%, elaboration dimension obtained 87% and novelty dimension obtained 63%. The comparison of students' creativity result for each dimension can be seen clearly in Figure 1.

The average score of each dimension creativity after implementing STEM project-based learning is obtained 76% which categorized as good based on Purwanto (2009). Based on the result of this study, students who learn light and optics through STEM project-based learning has good creativity. Students are trained to realize their ideas by designing and constructing the product in STEM project-based learning. Thereby, students were given the opportunity to develop their idea by using several tools and materials that can improve the quality of the product. It can be inferred that students' who learned science by using STEM project-based learning have good creativity. The result is in line with the study that is conducted by Lou, Chou, Shih, & Chung (2017) who stated that the implementation of STEM project-based learning gives the positives influence on the effective development of creativity. The result of this study also in line with the previous finding which stated that STEM approach, especially in hands-on activity through project-based learning, requires students to think critically and creatively (Siew, Amir, & Chong, 2015).

In the preparation stages, students are freely given an opportunity to investigate the problems and find some information that needed to solve the problems from the internet. This is appropriate with Munandar (2004) who stated that creativity can be developed in a free situation to conduct an investigation. Preparation stages also give an opportunity for students to discuss with their group in determining the project based on information that is obtained from the internet. The discussion is used to stimulate students in delivering their idea. It is in line with Rustaman, et. al. (2003) who stated that discussion gives several advantages to stimulates students' courage and creativity in expressing their idea, students also have responsibilities for the result of group discussion.

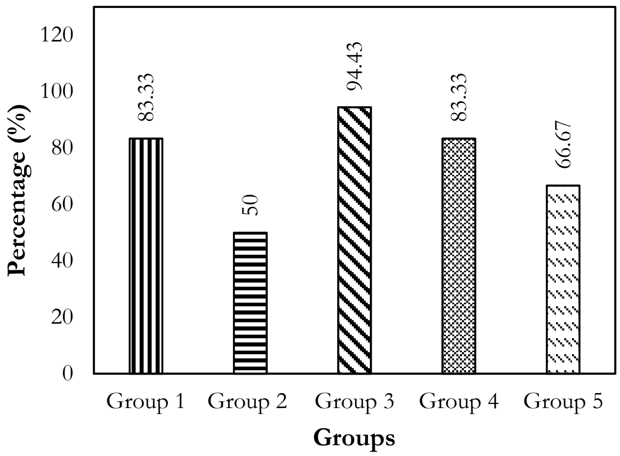

Figure 2 Students' creativity result for each group

In implementation stages, students conduct an experiment to create the product that has been designed. Furthermore, students conduct an actual test to make sure that their product is working. Munandar (1999) stated that creative thinking skill can be developed through experiment and discussion activity between students.

In presentation stages, students try to communicate their product and also their design. Students express some obstacles that they are faced in making the project. As it is known that expressive is one criterion of elaboration dimension. Students should think creatively, how to draw attention when present the product. Expressive criteria refer to the product is presented with the communicative way and understandable manner (Besemer & Treffinger, 1981).

In the evaluation and correction stages, students made a repairment to improve their product. These stages become a reflection for students to find how is the best way to improve the quality of the product. One of effective teaching should give students opportunities for reflecting their own thinking, receiving feedback from other students, and revising the ones' thinking as a result of new information freely. Capraro, Capraro, & Morgan, (2013) stated that the effective instruction should provide the opportunities for students in evaluating scientific evidence based on their own understanding, connecting the theory with their own explanation, and participating active learning. In this case, students' creativity plays a role in creating an effective solution to repair students' product.

When conducted STEM project-based learning, the class is divided into five groups that consist of five students to create the project. All group members should cooperate with each other in making a simple projector. The recapitulation of students' creativity for each group is presented in Table 7.

Based on the result in Table 7, there are different achievements of creativity for each group. Group 1 obtained 83.33%, group 2 obtained 50 %, group 3 obtained 94.43%, group 4 obtained 83.33%, and group 5 obtained

Table 7 Students creativity result for each group

Gro-up	Creativity Dimension			Average
	Resolution	Elaboration	Novelty	
1	83.33%	100%	66.67%	83.33%
2	50%	66.67%	33.33%	50%
3	100%	83.3%	100%	94.43%
4	83.33%	100%	66.67%	83.33%
5	66.67%	83.33%	50%	66.67%

66.67%. Based on the result, there is a distant gap in creativity result between group 2 with another group, because group 2 has the lowest percentage of creativity. The comparison of students' creativity results for each group can be shown in Figure 2.

The distant gap can be found between group 3 and group 2. Group 3 has the highest percentage of creativity which obtained as much 83% categorized very good. Meanwhile, group 2 has the lowest percentage of creativity which obtained as much 50% categorized as very lack creativity. Group 2 also has the lowest percentage of three creativity dimension if compared with other groups.

When making the creative product, the class is divided into groups. Thus, each group worked and discussed together to developed their idea in making the creative product. Based on the result, each group has different attainment of creativity. However, there is a distant gap in creativity result between group 3 which categorized as very good and group 2 which categorized as very lack. The condition happened because group 2 always bicker among member when making the product. They blame each other if there is a member who is negligent with responsibilities. As the result, group 2 not take an effort to improve the quality of the product, while other groups attempted to improve their product quality. The students' product after implementing STEM project-based learning can be shown in Figure 3.

Figure 3 Students' product in making a simple projector

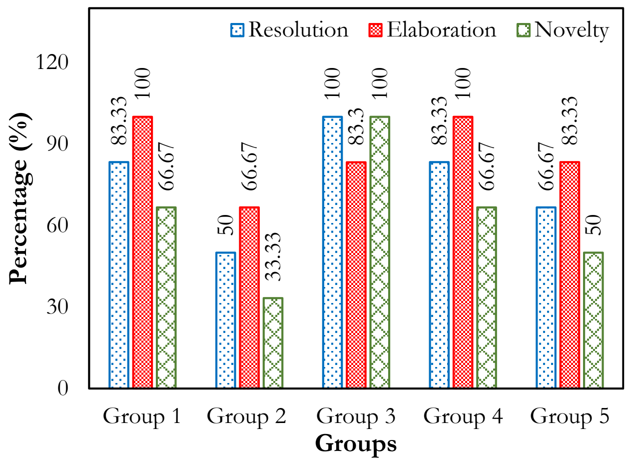

Figure 4 Creativity dimension for each group

Three creativity dimension of all groups have a different percentage. Group 2 has the lowest percentage of three creativity dimension compared with other groups. To make the comparison of each dimension creativity between all groups can be seen clearly, the result also changes into graphical form. The creativity result for each dimension creativity can be shown in Figure 4.

4. CONCLUSION

The students who implemented STEM project-based learning in the concept of light and optics have good creativity in the dimension of resolution, elaboration, and novelty. The creativity result that obtained as much as 76% which is categorized as good. STEM project-based learning can be used as alternative teaching strategies in Junior Secondary School.

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Improving Students' Sustainability Awareness through Argument-driven Inquiry

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ABSTRACT Sustainability awareness is one of the things that the student should have to help in a caring environment. Sustainability awareness of the student can be built by knowledge and awareness of what should be done or not. The student will be more aware of the students involved and explore more in building a concept about the environmental issue itself. The aim of this study is to investigate the impact of Argument-Driven Inquiry toward students' sustainability awareness in learning global warming. The method used in this research was experimental research. This study used two different groups of student. The first group learned using Argument-Driven Inquiry and the second group learned using Inquiry-based Learning. The population was seventh-grade students in one of Junior Secondary School in Bandung, Indonesia. The purposive sampling technique was used to choose the sample. The participants consist of 52 students from both groups. Each group consists of 26 students. The data were collected by giving the questionnaire of sustainability awareness. The questionnaire consists of 15 items. The result of this study shows the different percentage in the level of students' sustainability awareness between the two groups. The most different percentage is on the sustainability practice awareness aspect. The group that used Argument-Driven Inquiry has percentage 40.7% which means as medium and the group that used Inquiry-based Learning has percentage 37.6% which means as low. Based on the result, Argument-Driven Inquiry gives a better impact on students' sustainability awareness. Argument-Driven Inquiry can be considered as one of the alternative teaching models that can give a better understanding in building the awareness of Junior Secondary School student.

Keywords Sustainability awareness, Argument-driven inquiry, Global warming

1. INTRODUCTION

Argument-Driven Inquiry is the learning model that conducts argumentation session in the part of the learning process. Argument-Driven Inquiry has the purpose to give more place of argumentation in the inquiry process in order to improve the learning outcome (Hasnunidah, Susilo, Irawati & Sutomo, 2015). Argument-Driven Inquiry has seven steps of learning which are the argumentation session is included. Argumentation is one of the ways to facilitate the students in gaining the concept and gaining more reason behind the process of phenomenon happens in nature. The inquiry is often used in the learning activity and argumentation is one of the important things that support the inquiry in the learning process (Aulia, Poedjiastoeti, & Agustini, 2018). According to Demircioglu & Ucar (2015) stated that argumentation is not really often to be implemented in learning science.

The implementation of argumentation in learning global warming is one of the important things to support and help a student in explaining the phenomenon. By argumentation, the student can explore more the idea about how and why global warming happens. Global warming is a topic that discusses the environmental issue that happens in nature. The participation of students in environmental issue has been basically built at the school. Besides the theoretical knowledge, the awareness of the environmental issue is also one thing that should the students have (Hamid, Ijab, Sulaiman, Md. Anwar & Norman, 2017). Students are most likely to do things for a personal material prize or awards because the most student is not doing something where they do not get any direct

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Table 1 Data of population and sample

Group	Population	Sample	N	Percentage (%)	Total (%)
First	7th grade	Male	14	53.80	100
		Female	12	46.20	
Second	7th grade	Male	13	50.00	100
		Female	13	50.00	

impact or advantage for them. According to Sammalisto, Sundström, von Haartman, Holm, & Yao (2016) stated that students tend to not doing something if there is no advantage for themselves. Sustainability awareness is one of the prerequisites for environmental attitude and behavioral change in caring the natural environment to impede climate change and global warming (Hamid, Ijab, Sulaiman, Md. Anwar & Norman, 2017). The students probably have a lack of awareness because they do not really understand what is happening in the environment or how global warming damages the environment. This can be a challenge for educators to build or improve the sustainability awareness of students. According to Hodson (2009) stated that the students should be able to have a reason in science, so they can relate the concept and daily phenomenon.

In recent years, many studies have been carried out the implementation of Argument-Driven Inquiry in learning science. Demircioglu and Ucar (2015) have investigated students' argumentation level and science process skill by using Argument-Driven Inquiry (ADI) in learning physic. The previous research from Cetin & Eymur (2017) has investigated students' writing skill and scientific presentation skill by using Argument-Driven Inquiry (ADI) in learning chemistry. Another research from Walker, Sampson, Southerland, & Enderle (2016) has investigated students' academic achievement by using Argument-Driven Inquiry (ADI) in learning chemistry. However, the research that investigates students' sustainability awareness by using Argument-Driven Inquiry (ADI) has not been researched yet. Therefore, this study engaged the concept of climate change, greenhouse effect, and the impact of global warming that utilizes argumentation during the learning process to build the awareness of students about the environment. The aim of this study is to investigate the impact of Argument-Driven Inquiry on students' sustainability awareness in learning global warming.

2. METHOD

2.1 Research Method

This study used the quasi-experiment method. Quasi-experiment is where the treatment is administered to only one of two groups whose members were randomly assigned (Creswell, 2012). This study was conducted in two different groups of student. The first group learns using Argument-Driven Inquiry and the second group learns using Inquiry-based Learning.

Table 2 Questionnaire sustainability awareness

No	Statement	Response	
		Yes	No
1	I read about environmental issues in the mass media		
2	I concern about environmental problems at my place		
3	I always discuss environmental problems with my friends		
4	I feel disappointed with air pollution		
5	I feel disappointed with river pollution		
6	I appreciate biodiversity		
7	I concern about smoke that is emitted by vehicles		
8	I try to reduce the amount of waste at home by collecting materials that can be recycled		
9	I composting the food residue to become fertilizer		
10	I do not use a plastic bag to wrap things		
11	I conserve the use of electric energy at home		
12	I conserve the use of water supply		
13	I deliver information on the environment to my family members		
14	I involve in the environmental awareness activities in school		
15	I aware of my responsibility towards the environment		

2.2 Population and Sample

The location of this study was in one of Junior Secondary School in Bandung, Indonesia. The school used curriculum 2013. The population of this study was seventh-grade students with aged ranged between 13-14 years old. The sample consists of 52 students: 26 (12 female, 14 male) in the first group and the 26 (13 female, 13 male) in the second group. The sample was chosen by purposive sampling technique. Fraenkel, Wallen, & Hyun (2012) stated that purposive sampling is defined where the researcher uses the judgment to select a sample that they believe, based on prior information, will provide the data they need. The data of the sample can be seen in Table 1.

2.3 Research Instrument

The data was gathered by giving the questionnaire of sustainability awareness to the students. The questionnaire is adopted from Hassan, Noordin, & Sulaiman (2010) that consist of three aspects of sustainability awareness which

Table 3 Sustainability awareness interpretation

Sustainability Awareness Value	Criteria of Percentage Response
0.0–39.9	Practices that seldom or dislike being done/low
40.0–69.9	Practices that are done/ happened moderate/medium
70.0–100	Practices/feelings that are most likely one/happened/high

Table 4 Sustainability awareness in the first group

Aspect : Sustainability Practice Awareness	Statement Yes	No	Number of Data
Item 3	12	14	
Item 9	5	21	
Item 10	9	17	
Item 13	14	12	
Item 14	13	13	
Total	53	77	130
Percentage Response	40,76923		
Aspect : Behavioral and Attitude Awareness	**Statement Yes**	**No**	**Number of Data**
Item 1	18	8	
Item 6	22	4	
Item 7	24	2	
Item 8	12	14	
Item 11	22	4	
Item 12	22	4	
Total	120	36	156
Percentage Response	76,92308		
Aspect : Emotional Awareness	**Statement Yes**	**No**	**Number of data**
Item 2	22	4	
Item 4	25	1	
Item 5	26	0	
Item 15	24	2	
Total	97	7	104
Percentage Response	93,26923		

are sustainability practice awareness, behavior, and attitude awareness, and emotional awareness. The questionnaire consists of 15 items with "yes" and "no" choices. The questionnaire of sustainability awareness is shown in Table 2. Items 3, 9, 10, 13, 14, represent students' sustainability practice awareness. Items 1, 6, 7, 8, 11, 12 represents students' behavioral and attitude awareness. Items 2, 4, 5, 15 represent students' emotional awareness.

2.4 Research Procedure

In this study, Argument-Driven Inquiry was implemented in the first group. There is seven steps of Argument-Driven Inquiry which are identifying the task and guiding question, design a method and generate data, production of tentative argument, argumentation session, write an investigation report, double-blind group peer review, revise and submit a report. Inquiry-Based Learning was implemented in the second group. The step of Inquiry-Based Learning includes Identification of the problem, questioning, making a hypothesis, collecting data, analyzing data, and making a conclusion. Both groups were given the topic of global warming. The concept of global warming is limited based on Indonesian Curriculum 2013. The research was conducted in four meetings. The first meeting until the third meeting was for the treatment of Argument-Driven Inquiry and Inquiry-Based Learning, and the fourth meeting was for giving the questionnaire to the students.

Table 5 Sustainability awareness in the second group

Aspect : Sustainability Practice Awareness	Statement Yes	No	Number of Data
Item 3	11	15	
Item 9	1	25	
Item 10	6	20	
Item 13	15	11	
Item 14	16	10	
Total	49	81	130
Percentage Response	37,69231		
Aspect : Behavioral and Attitude Awareness	**Statement Yes**	**No**	**Number of Data**
Item 1	16	10	
Item 6	23	3	
Item 7	24	2	
Item 8	9	17	
Item 11	22	4	
Item 12	22	4	
Total	116	40	156
Percentage Response	74,35897		
Aspect : Emotional Awareness	**Statement Yes**	**No**	**Number of Data**
Item 2	18	8	
Item 4	24	2	
Item 5	24	2	
Item 15	24	2	
Total	90	14	104
Percentage Response	86,53846		

3. RESULT AND DISCUSSION

Students' sustainability awareness data was collected by conducting questionnaire that consists of 15 items with "yes" and "no" answer options. Students' sustainability awareness has three aspects and it is analyzed by calculating the percentage of each aspect. The questionnaire consists

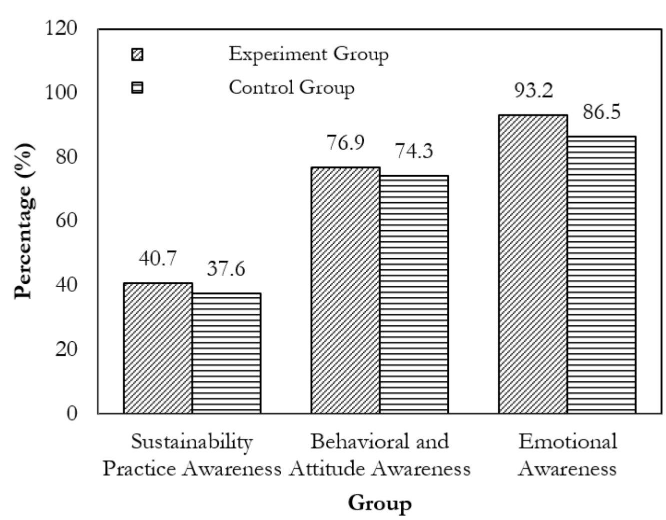

Figure 1 Percentage on each aspect of sustainability awareness

of items that represent all aspect of sustainability awareness. The level of sustainability awareness is determined based on the percentage score from Hassan, Noordin, & Sulaiman (2010) that is interpreted in Table 3.

The percentage of students' sustainability awareness was analyzed using Microsoft Excel. Sustainability awareness has three aspects, there are sustainability practice awareness, behavioral and attitude awareness, and emotional awareness. In each aspect, the number of "yes" and "no" answer is calculated and the number of "yes" answer will be divided by the number of all the students' answer both "yes" and "no" on the items of a certain aspect. The analysis of the percentage of sustainability awareness in the first group is shown in Table 4, and the analysis of the percentage of sustainability awareness in the second group is shown in Table 5. The result of students' sustainability awareness in the first and the second group can be seen in Figure 1.

Based on Figure 1, those three aspects of both groups have a different percentage. The percentage of sustainability practice awareness aspect in the first and second group has a different category. In the first group is 40.7% which categorized as medium, while the second group is 37,6% which categorized as low. The result means that the first group student has better practice awareness such as discussing or delivering information about

Table 6 Students' activity in the first group

The step of Argument-Driven Inquiry	Description of Activities	Observed Activities
First Meeting		
Identification of the task and guiding question	The students observe picture and video about climate change.	Most of the students are a very enthusiast in watching video
Designing method and generate data	The students are divided into 5 groups and each group is designing the procedure of experiment about the impact of CO_2 toward temperature.	Some student did not bring tools and materials for the experiment, so other groups have to share and sometimes the number of tools and material is not enough.
Production tentative argument	The students analyze the data from the experiment and finding the evidence to support their findings.	The students write the tentative argument on the worksheet
Argumentation session	Each group delivers argumentation based on the problems that are given on the worksheet. Among groups can perceive, criticize, oppose, and support the statement during this session.	Some students are not conducive, so it disturbs other students who are presenting.
Write an investigation report	The students are making a report by completing the worksheet.	The students are completing the worksheet
Submit the report	The students submit the worksheet as their practical report.	The students submit the worksheet
Second Meeting		
The step of Argument-Driven Inquiry	**Description of Activities**	**Observed Activities**
Identification of the task and guiding question	The students observe picture and video about the greenhouse effect.	Most of the students are a very enthusiast in watching video
Designing method and generate data	The students are divided into 5 groups and each group is designing the procedure of experiment about the greenhouse effect.	The experiment needs sunlight as the heat energy. There was lack of sunlight so the result of the experiment not really clear.
Production tentative argument	The students analyze the data from the experiment and finding the evidence to support their findings.	The students write the tentative argument on the worksheet
Argumentation session	Each group delivers argument based on the problems that are given on the worksheet. Among groups can perceive, criticize, oppose, and support the statement during this session.	Some students are not conducive, so it disturbs other students who are presenting.
Write an investigation report	The students are making a report by completing the worksheet.	The students are completing the worksheet
Submit the report	The students submit the worksheet as their practical report.	The students submit the worksheet
Double-blind peer review	The student submitted the assignment of making an article and reviewed and given feedback by their classmate	The teacher asked the student to make a hand-writing article, but some student makes it in the type-writing article.

environmental problems and doing environmental awareness activity. Based on the number of percentage of behavioral and attitude awareness and emotional awareness aspect in both class have almost the same percentage. In the first group is 76,9% and the second group is 74,3%. The behavioral and attitude awareness aspect in both groups is categorized as a medium. The result means that both groups of student have the same level of awareness to implement activities such as conserve energy and water, and recycling. The emotional awareness aspect of the first group is 93,2% and the second group is 86,5% which is categorized as high. The result means that the students in both classes are very aware of the response to environmental issues that happen.

From the data, it shows that the students from both groups are really aware of the responsibility to the environment. Students were very aware of their responsibility to environmental problems around them. They felt "very disappointed" about air and river pollutions. This is in line with the research from Hassan Hassan, Noordin, & Sulaiman (2010) that the emotional awareness aspect of the student is high. The students understand and know that there must be a balance between environments.

The behavioral and attitude awareness aspect in both classes is medium. For behavioral and attitude awareness aspect, students are required to implement actions such as reading environmental issues, appreciating, recycling, and conserving energy and water. The result of behavior and attitude awareness in research from Hassan Hassan, Noordin, & Sulaiman (2010) is also medium. It said that the students may not really have high awareness in reading environmental issues and appreciating environmental condition around them.

The sustainability practice awareness aspect has the lowest percentage among another aspect. This aspect is very difficult to be achieved. This is in line with the study from Hassan, Rahman, & Abdullah (2011) that students had a good awareness of environmental problems but yet had not changed in practice. The student should have awareness in discussing or delivering information about environmental problems and doing environmental awareness activity. The students might get environmental and awareness lesson from home and school. Knowledge is the thing that affects practice. The different percentage of two groups is caused by the model that was implemented in the class. The activity of the first group in all meetings

Table 7 Students' activity in the second group

First Meeting		
The step of Inquiry-Based Learning	**Description of Activities**	**Observed Activities**
Identification of the problem	The students observe picture and video about climate change.	Some students are an enthusiast in watching video
Questioning	The students are asked to make question-based on the problem on the video	Most of the students are keep silent and not give any question.
Making hypothesis	The students are stimulated to make a hypothesis about the cause of climate change.	The students write the hypothesis on the worksheet
Collecting data	The students are divided into 5 groups and each group conducting an experiment about the impact of CO_2 toward temperature	Students are not conducive. Some students do not want to discuss with the group because they feel uncomfortable with each other.
Analyzing data	Each group discusses to analyze the data that is obtained from the experiment on the worksheet and deliver the result of the class.	Only a few students try to analyze and solve the question on the worksheet. Some students are just quiet or very noisy.
Making a conclusion	The students are led to make a conclusion	Some students try to give the conclusion
Second Meeting		
The step of Inquiry-Based Learning	**Description of Activities**	**Observed Activities**
Identification of the problem	The students observe picture and video about the greenhouse effect.	Some students are an enthusiast in watching video
Questioning	The students are asked to make question-based on the problem on the video	Most of the students are keep silent and not give any question.
Making hypothesis	The students are stimulated to make a hypothesis about the cause of greenhouse effect.	The students write the hypothesis on the worksheet
Collecting data	The students are divided into 5 groups and each group conducting an experiment about the greenhouse effect.	Students are not conducive. Some students do not want to discuss with the group because they feel uncomfortable with each other.
Analyzing data	Each group discusses to analyze the data that is obtained from the experiment on the worksheet and deliver the result of the class.	Only a few students try to analyze and solve the question on the worksheet. Some students are just quiet or very noisy.
Making a conclusion	The students are led to make a conclusion	Some students try to give the conclusion

can be described in Table 6. The activity of the second group in all meetings can be described in Table 7.

From the Table 6 and 7, it can be seen that the first group that used Argument-Driven Inquiry, the students are asked to have argument about what and why they have to do, such as arrange the procedure of experiment, filling the solution of the problem on the worksheet and argue it in class, while in the second group is different. The inquiry process itself gives more benefit to students in improving knowledge (Wardani & Winarno, 2017). The inquiry process that is supported by argumentation gives more space to the student to explore the idea.

In the first group, there is also a step called double blind-peer review. The group of students in each class is asked to make an article that discusses alternative energy, what activity that can be done to maintain our surrounding at home and school, and what simple activity that can be done routinely to reduce the global warming. Then, the article will be reviewed or given any feedback by their classmate without knowing whose article they assessed and who assessed their article, then the article will be given back to the group author to be revised and submitted. While in the second group there is no double-blind peer review. The students are only asked to make the same theme article and then submit it directly to the teacher.

By having those arguments in learning global warming, the students can integrate the environmental condition, social, and economic dimensions of sustainability issues. The students can relate their past, present, and future condition so that the students gain a better understanding. At the same time, by arguing allows students to have a different point of views and opinions to be solved. The students can reflect on what is happening in global warming, what is being learned, and critically make the decision to participate in handling the problem of the topic which is learned in the classroom. This is in line with the result from Pauw, Gericke, Olsson, & Berglund (2015) that as the teacher integrate the environmental condition on the past, present, and future, the students gain the more knowledge and critically reflect on what is happening and participate in decision making to practice their knowledge. The previous study from Labog (2017) found that the learning process on concept and practice at school can help in strengthening the linkage to the environment to achieve sustainability awareness. The more knowledge will increase the students' practice awareness. This is in line with the statement from Sivamoorthy, Nalini, & Kumar (2013) that knowledge does not influence emotional and behavior, but influence the students' practice awareness.

This level of sustainability practice awareness needs to be built more in education at school. Besides theoretical knowledge, the school needs to give more practical experience to trigger the intended lifestyle or behavioral change among students, so that the students will have more sustainability practice awareness (Hamid, Ijab, Sulaiman, Md. Anwar, & Norman, 2017). The teacher should develop the criteria that still lack in students to develop sustainability awareness. However, Cottrell & Graefe (1997) stated that behavior in terms of environmental practices was a complex task and influenced by many other factors.

Comparing the activity in both groups, the first group and second group have different activities. Based on table 6, in the first group which used Argument-Driven Inquiry, there is argumentation session in the activity, while in the second group there is no argumentation session. In the first group, the students participated more in a group discussion during the argumentation session. The students have more opportunity to explore the idea. Each group delivered argument based on global warming problems. Among groups perceive, criticize, oppose, and support the statement during this session. Then, the teacher clarified the students' opinion. In argumentation session, students had more opportunity to exchange the ideas in class. In the first group, there was also a double-blind peer review. The students submit the assignment of making an article and the article was reviewed and given feedback by their classmate. These two activities are the most influenced the level of sustainability awareness of students. By increasing more knowledge of students about global warming, the students' will learn more about how to be aware of the environment.

4. CONCLUSION

Argumentation in the learning process helps the student to explain how the phenomenon happens. Argumentation in the inquiry process also helps the student to gain more reason behind a process of the phenomenon itself. The students in the experimental group have a higher percentage in all aspects. The difference can be seen clearly in the sustainability practice awareness aspect which is the first group that used Argument-Driven Inquiry has the medium percentage, while the second group has a low percentage. It can be concluded that Argument-Driven Inquiry helps the students in gaining the higher percentage on sustainability awareness in all aspects. Argument-Driven Inquiry can be considered as one of the alternative teaching models that can give a better impact on students' sustainability awareness.

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Development of Smart Content Model-based Augmented Reality to Support Smart Learning

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ABSTRACT Augmented Reality (AR) is an optical technology that combines virtual objects or worlds into real worlds like in real time and increases user perceptions and interactions with the real world. Information conveyed by virtual objects helps users carry out activities (tasks) in the real world. The convenience offered makes AR technology can be used for various fields, including education, such as the development of materials or learning media. Augmented reality in its development is more comfortable, cheaper, and can be widely implemented in various multimedia needs. This research is a study of the development of multimedia based on augmented reality to produce dynamic learning materials or media in supporting the concept of smart learning. This research provides multimedia models of mathematics for circles, ellipses, parabola, and hyperbole based on augmented reality to create more dynamic learning as smart learning. Multimedia is produced according to operational standards and meets content standards based on media experts, content, and users. Multimedia-based augmented reality math is easy to operate, helps, and increases understanding and increases student motivation.

Keywords Augmented Reality, Multimedia Learning, Smart Learning

1. INTRODUCTION

Along with the current technological developments, the learning media always follow the progress of existing technology (Reisse, Heider, Giersich, & Kirste, 2008). The oldest technology utilized in the learning process is printing that works on the basis of mechanical principles, then audio-visual technology that combines mechanical and electronic inventions for teaching purposes, the latest emerging technology is the microprocessor technology that spawned the use of computers and interactive activities (Reisse, Heider, Giersich, & Kirste, 2008). Based on these technological developments, the teaching media is divided into four parts, namely: (1) Media resulting from printing technology, (2) Media resulting from audio-visual technology, (3) Media result of computer-based technology, (4) Media combined print technology and computers (Dekdouk, 2012).

Referring to the classification of learning media was born a combined learning media of print and computer technology known as AR (Augmented Reality) an optical technology that combines the object or virtual world into the real-world view in real time. Also, Augmented Reality improves perception and interaction of users with the real world. The virtual object displays information that the user can not directly detect with his senses. The information presented by the virtual object helps the user perform real-world activities/tasks (Azuma, 1997). AR is one of the most exciting technologies of interest; AR presents an immersive level in which none of the virtual tools can do it. The convenience offered makes AR technology usable to various fields, such as military, medicine, education, industrial engineering, to entertainment.

There are many learning models, based on smartphone technology that need to be supported with more real and dynamic content, especially the content aspect which is one of the characteristics of smart learning (Di, Gang, & Juhong, 2008). One of the dynamic content can be developed with AR technology, making learning more dynamic and exciting.

The tendency of learning that is less attractive is one of them due to the use of even static media using technology. The use of information and communication technology

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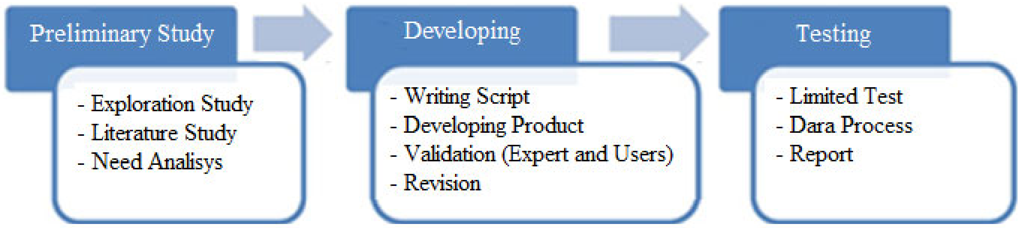

Figure 1 Research procedure

based multimedia learning is quite lively, but the application of AR technology is still low (Dekdouk, 2012).

For content that involves multiple dimensional objects, AR much helps build object abstractions for students' understanding. The idea of the concept of area and space has severe problems in mathematical content such as circles, ellipses, parabola, and hyperbole. Based on the above problems, this research examines the development of learning media using augmented reality technology for learning mathematical material circles, ellipses, parabola, and hyperbole. The main problem of research is: "How to Develop Multimedia Based On Augmented Reality To Support Smart Learning." From the formulation of the main problem, the researcher divides the research question into small points as follows: (a) How to design and develop learning multimedia based on augmented reality? (b) How is the feasibility of learning multimedia based on augmented reality developed for a limited trial? (c) The primary purpose of this research is the development of multimedia-based Augmented Reality for student learning activities. The specific objectives are: (a) The acquisition of multimedia learning model based augmented reality? (b) Knowing the feasibility of multimedia learning model based augmented reality developed before being tested in a limited way.

2. METHOD

The main objective of this research is to develop augmented reality-based media to support smart learning for students of junior high school. In general, the development of learning media, based on augmented reality to support quick learning consists of 3 (three) significant steps, namely preliminary studies, product development, and testing as seen in Figure 1 (Dekdouk, 2012). This research conducted in the Department of Computer Science Education, Faculty of Mathematics and Natural Sciences Education, Universitas Pendidikan Indonesia.

The research steps are as follows:

2.1 Preliminary Study

At this stage set the goal of software development, both for students, teachers, and the environment. For this purpose, the analysis is done in cooperation with the teacher and still refers to the curriculum used. In addition to the objective analysis, analysis of software development needs is also required. Needs analysis is the first stage that becomes the basis of the next software development process. The smoothness of the entire software creation process and the completeness of the resulting software features are highly dependent on the results of this needs analysis. To obtain information about the needs in making this interactive learning media, researchers through explorative studies and literature study (Azuma, 1997).

2.2 Developing

This stage includes the determination of the elements that need to be loaded in the multimedia learning that will be developed based on the design of learning or often referred to as the ID model (Instructional Design). The results of this stage include a storyboard (storyboard), which is how this multimedia is displayed (interfacing). How to present materials, 3D models for learning, animation, evaluation, and more. Also, the result of this step is the interactive multimedia learning system flowchart from start to program until the end of the plan (Ardhianto, Hadikurniawati, Winarno, 2012; Kemp & Dayton, 2003).

This stage is the stage of multimedia learning development based on a storyboard that has been made, making multimedia such as 3D model and animation until evaluation, storyline creation, integration among all these aspects, and program design. After that, judgment is made to the expert. This assessment covers the assessment of interfaces, text, 3D models, interactivity and the content of learning (Ardhianto, Hadikurniawati, & Winarno, 2012, Kemp & Dayton, 2003).

2.3 Assessment Stage

To measure the results of the expert judgment, the Scale Rating scale is used. Rating Scale or scale is a subjective measure made scale (Kemp & Dayton, 2003). The rating scale is not limited to the measurement of attitudes alone, but to measure respondents' perceptions of other phenomena, such as scales for socioeconomic status, institutional status, knowledge, skills, the process of activities and others (Kemp & Dayton, 2003).

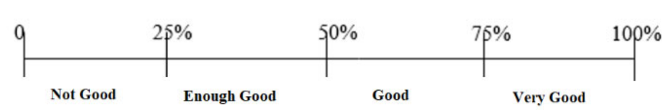

Figure 2 The criterion score

Figure 3 MatSemat card model

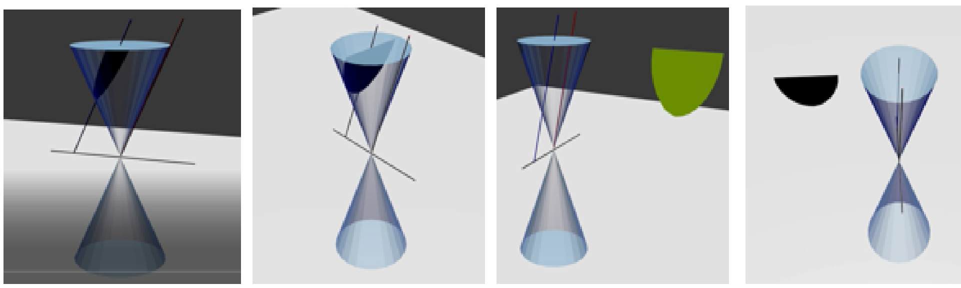

Figure 4 Illustration of cone slice

Regarding aspects assessed at the expert validation stage, the adaptation of the multimedia learning development criteria. These Aspects are Common Aspects, Aspects of Media, Aspects of Learning, and Visual Communication Aspects (Cawood, Fiala, & Steinberg, 2007).

The data that has been collected in the validation questionnaire is qualitative data because each statement item is divided into a very bad, bad, useful, and excellent category. To calculate the data first into quantitative data by the weight of the score of one, two, three, and four. After the data is transformed, then the calculation of the rating scale can be done with the following formula (Azuma, 1997).

$$P = \frac{actual\ score}{ideal\ score} \times 100\%$$

Note:
P = Percentage

The interpretation scale is made by dividing the criterion score into four continua then the continuum result is made as the following categories in Figure 2 (Azuma, 1997). Qualitative data, such as comments and suggestions, serve as a basis for revising interactive multimedia learning.

3. RESULT AND DISCUSSION

3.1 Multimedia Products

The resulting multimedia is -based augmented reality for learning conic sections consisting of circular, parabolic, elliptical, and hyperbola materials. Learning tools consist of material books, object cards, and a camera or mobile phone. The map includes all the image objects present in the book for ease of use and is named MatSemat as a Mathematic Smart extension. The image code is adjusted between the paper and the card based on the material affairs set out in the book. Figure 3 and 4 is an example of augmented based multimedia card (Santoso & Gook, 2012; Geroimenko, 2012). The front page of the card contains the logo of Universitas Pendidikan Indonesia; the back includes an image of the object, the number of the picture according to the book, the name of the drawing, and the short description.

3.2 Products Judgment by Experts and Users

3.2.1 Multimedia Aspect Judgment

Using 3 (three) essential parameters of an electronic media, namely general aspects, software engineering, and visual communication, media experts provide an assessment as in Table 1. From Table 1. it can be shown, according to media experts that the multimedia developed has an outstanding category and in a contingent basis with average feasibility of 87.61% which is categorized very high and in the continuum as shown in Figure 5.

Table 1 Assessment of media aspect

Aspec	Sum Expert	Sum Comp.	Ideal Score	Actual Score	%
G	2	3	30	26	86.67
SE	2	9	90	80	88.89
VC	2	11	110	96	87.27
Average					87.61

Note:
G: General; SE: Software Enginnering; VC: Visual Communication

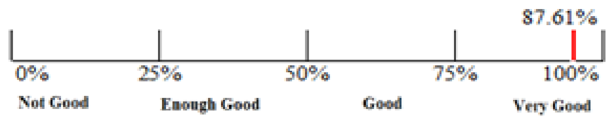

Figure 5 Critical scale assessment of media experts

Multimedia-based augmented reality generated is declared appropriate for use in learning circles, parabola, ellipses, and hyperbole. Multimedia produced contributes to learning, including the following (Kemp and Dayton, 2003). (1) Submission of learning messages can be more standardized. (2) Learning can be more enjoyable. (3) Learning becomes more interactive by applying learning theory. (4) The time for implementing learning can be shortened. (5) Quality of learning can be improved. (6) The learning process can take place whenever and wherever needed. (7) The positive attitude of students towards learning materials and the learning process can be improved. (8) The role of the teacher experiences changes in a positive direction.

3.2.2 Content Aspect Judgment

Assessment of material aspects uses 3 (three) essential parameters of an electronic media, namely general elements, content subject; and learning. Material experts provide an assessment, as stated in Table 2. From Table 2., it can be shown that the multimedia assessment by material experts found an average percentage of the feasibility of 87.22%, which is categorized very high and in contour, as shown in Figure 6.

Multimedia-based augmented reality generated was declared feasible by material experts for use in learning circles, parabola, ellipses, and hyperbole. Material aspects show feasibility above average, while the other two points are below average. This indicates that multimedia based on augmented reality can extract material richer, more varied, detailed, and dynamic. Such dynamic learning media are by the characteristics of students as some millennia, including fun, multitasking, and random access (Trilling & Fadel, 2009).

Table 2 Assessment of ascpect matter

Aspect	Num Expert	Num Comp.	Ideal Score	Actual Score	Quality (%)
G	2	3	30	26	86.67
CS	2	4	40	34	85,00
L	2	12	120	108	90,00
Average					87.22

Note:
G: General; CS: Content Subject; L: Learning

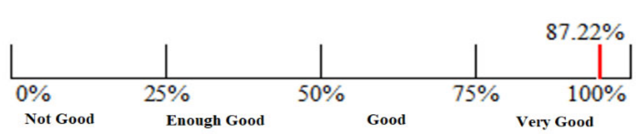

Figure 6 Critical scale material assessment

Table 3 User Assessment

No.	Aspect	Quality (%)
1	Navigation key in multimedia	80,00
2	Multimedia View	83,36
3	Ease of Use Multimedia	83,33
4	Multimedia Interactivity	8 0,00
	Average	81,67

Figure 7 User critical scale

3.2.3 Assessment By Users

User assessment is an operational aspect of multimedia that is more precisely testimony. The operational element uses 4 (four) essential parameters of an electronic media, namely completeness, and clarity of flow, compatibility/suitability of appearance, ease of operation, and interconnection, interactivity. The users provide an assessment, as stated in Table 3. From Table 3, it can be shown that according to prospective users, the average percentage of feasibility is 81.67%, which is categorized very high, and on a continuum, as shown in Figure 7.

Multimedia-based augmented reality generated is expressed according to operational standards and is appropriate for users to use in learning circles, ellipses, parabola, and hyperbole. Navigation and interactivity aspects are below average, while the appearance and convenience are above average. In this context, prospective users, namely students, pay more attention to the presentation, and ease of operation. Assessment of potential users is lower than media experts. This shows that the millennial generation has been waiting to interact with the media like that, especially those that smell like games that feature appearance (Trilling & Fadel, 2009).

Table 4 Target test

No.	Results
1	Tracking works well, but the distance between the camera and the marker is not too close.
2	The display looks ideal on the tracking process with a viewing angle of $45^{o,}$ and the target is seen entirely.
3	The target looks too small with a 60^{o} viewpoint, and in this case, the tracking process works long enough.
4	The target looks too small, with a 70^{o} point of view, and in this case, the tracking process cannot work.

Table 5 Distance test

Elevation	Dintance (Cm)
0	10, 15, 25, 50
30	10, 15, 50
45	10, 15, 25, 50

3.3 Multimedia Visibility

To determine media visibility, black box testing is carried out by looking at the input, treatment, response, sensitivity, output, or event changes. For this reason, alpha and beta testing techniques are used.

3.3.1 Alpha Testing

Alpha testing is done to see the initial condition of the media. The initial term of the media is the reading or introduction of marker objects by the camera until the final output of the object. The following are the results of testing the target object, as shown in Table 4. The next test is the distance between the camera and marker, the reflection of light and the success of the camera's tilt angle at a minimum illumination of bright lights or cloudy sunlight and the results are read well at some angles of distance funds as seen in Table 5. The alpha test results show the success of excellent and visible viewing of augmented reality objects. With bright levels of natural sunlight, augmented objects can be observed. The tilt angle 0^{o}-45^{o} is a standard limit for smartphone users, as well as a distance of 10-50 cm is an average distance that is naturally done or occurs (Geroimenko, 2012). The following are the results of the multimedia product journey test as to where Tables 6, 7, 8, and 9. The module starts running successfully, which is the initial gateway that checks all the readiness of multimedia devices to run (Geroimenko, 2012). The control module runs successfully, which is a guarantee of the running of the rules that have been set according to the set and expected flow (Geroimenko, 2012). The instruction module runs successfully, which is a guarantee of the running of the rules that have been set according to the predetermined and expected path (Geroimenko, 2012). The exit module works successfully, which is the finalization of the process of running the media. The output module creates an aggregate or dashboard of all processes that have been run electronically (Geroimenko, 2012).

Table 6 Starting menu test

Input	Expected	Observation	Conclusion
Click the "Star" menu	Displays notification information whether you want to leave the media or not	Displays a confirmation notification	Accepted

Table 7 Control test

Input	Expected	Observation	Conclusion
Click the "Control" menu	Displays notification information whether you want to leave the media or not	Displays a confirmation notification	Accepted

Table 8 Navigation test

Input	Expected	Observation	Conclusion
Click the "Help" menu	View information and how to play objects	Show game instructions	Shown

Table 9 Quit test

Input	Expected	Observation	Conclusion
Click the "Exit" menu	Display notification information whether to get out of media or not	Displays a confirmation notification	Accepted

3.3.2 Beta Testing

The beta test is the level of use or use of multimedia by the user which includes aspects of navigation, attraction, satisfaction, and perceived or acquired impacts as shown in Tables 10, 11, 12, 13, 14, and 15. In general, 87% of users stated that they were used to dynamic media, and only 13% said they were unfamiliar or familiar. The users mostly understand the flow that occurs in running a progressive media (Santoso & Gook, 2012). In general, 100% of users state that dynamic media is enjoyable to use in learning. All users agree that media augmented reality makes it happy in its implementation and matches the fun character of the millennial generation (Santoso & Gook, 2012). In general, 87% of users expressed satisfaction with dynamic media, and only 13% said they were less or dissatisfied. There are still things that need to be improved, especially the availability of existing or owned infrastructure (Geroimenko, V. 2012). In general, 100% of users say there are no difficulties and are accustomed to running dynamic media, and no users have trouble. This is in line with the digital age and users as millennials (Geroimenko, V. 2012). In general, 100% stated that they understood the material thoroughly from dynamic media, and no one indicated that they did not understand. Content that is presented

Table 10 Navigation test

Answer	Percentage (%)
Very helpful	27%
Help	60%
Doubt	13%

Table 11 Level of interest

Answer	Percentage (%)
Interested	53%
Doubtful	13%
Not Interested	0%

Table 12 Level of satisfaction

Answer	Percentage (%)
Very helpful	27%
Help	60%
Doubt	13%

Table 13 Level of convenience

Answer	Percentage (%)
Easy	83%
Ordinary	17%
Difficult	0%

Table 14 Level of material understanding

Answer	Percentage (%)
Yes	93%
Doubt	7%
No	0%

Table 15 Level of interest/motivation

Answer	Percentage (%)
Yes	57%
Doubt	30%
No	13%

dynamically is more acceptable and appreciated because it is easier to abstract in the minds of users or students (Geroimenko, V. 2012). In general, 87% of users stated that magnetic media motivated them, and only 13% said it was mediocre. Augmented reality media can increase learning motivation of most users (Geroimenko, V. 2012).

4. CONCLUSION

This study produced a multimedia learning model of mathematical material for circles, ellipses, parabola, and hyperbole based on augmented reality. Some things that can be concluded from this research activity are: *first,* As smart-based technology, smart content is needed to support quick learning. *Second*, multimedia-based augmented reality is part of smart content capable of making learning more dynamic. *Third*, multimedia-based augmented the reality of mathematical material for circles, ellipses, parabola, and hyperbole according to the standards of electronic media and dynamic learning. *Fourth,* multimedia-based augmented the reality of mathematical material for circles, ellipses, parabola, and hyperbole according to the character of millennial generations. *Fifth,* multimedia-based augmented reality of mathematical material for circles, ellipses, parabola, and hyperbole are generally attractive, easy to operate, facilitate understanding, increase motivation, and challenge.

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