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PROJECT- BASED LEARNING AND PROBLEM- BASED LEARNING: ARE THEY EFFECTIVE TO IMPROVE STUDENT'S THINKING SKILLS?

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ABSTRACT

The study aims at finding (1) the effect of project-based learning and problem-based learning on student's creativity and critical thinking and (2) the difference effect of project-based learning and problem-based learning on student's creativity and critical thinking. This study is quasi experiment using non-equivalent control-group design. Research population of this study was all classes in eleventh grade of mathematics and natural science program of SMA N 1 Temanggung. The participants were 102 students. This study used three classes as research sample which implemented three different kinds of learning models in respiratory system. XI MIPA 3 was as an experimental group implementing project- based learning and XI MIPA 5 was as an experimental group implementing problem- based learning, while XI MIPA 1 was as control group. Data was collected using two instruments to measure student's creativity and student's critical thinking. Data was analysed using t- test, multivariate analysis, and univariate analysis. The results reveal that (1) project-based learning and problem-based learning affect student's creativity and critical thinking; (2) there is a difference effect of project-based learning and problem- based learning on student's creativity; and (3) there is no difference effect of project-based learning and problem-based learning on student's critical thinking.

Keywords: project- based learning; problem-based learning; creativity; critical thinking; respiratory system

INTRODUCTION

The changing times that require individuals to master 21st century skills have an impact on education. The impact is a change in the learning activities. Learning in the 21st century should ensure students to have 21st century skills including skills, work habits, and characters that are believed to be essential to achieve successful life. Learning activities must ensure that students have (1) learning and innovation skills including critical thinking skills and problem solving, communication and collaboration, creativity and innovation; (2) information, media, and technology skills; and (3) life and career skills (Trilling & Fadel, 2009). To achieve these skills, students require an educational program that is capable in developing human resources in order to become a competitive personal.

In response to the changes in learning due to the demands of 21st century skills, the Indonesian government develops the 2013 curriculum. The 2013 Curriculum adapts concepts of 21st century skills, scientific approach, and authentic assessment. One concept adapted in the curriculum is the concept of a scientific approach that includes several learning models. The learning models recommended by the 2013 Curriculum are project-based learning, problem-based learning, discovery learning, and guided inquiry. The application of these learning models is expected to develop student's skill especially student's thinking skills, creativity, and critical thinking.

Learning in schools should be able to develop student's skills, one of which is the deve-

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lopment of creativity. Creativity development aims to prepare students in facing the challenges of the working world (Kind & Kind, 2007). In fact, student's creativity development in schools is still not optimal. Lack of attention to the development of creativity is caused by the notion that creativity cannot be learned and measured. Trilling & Fadel (2009) states that creativity can be learned in a learning environment that supports questions, patience, openness to new ideas, high trust, and learning from mistakes and failures. Creativity can be developed with continuous practice. One of the most effective ways to develop creativity is by learning through projects in order to find solutions to real-world problems.

PBL does not only equip the students with knowledge but also improve their problem-solving skill, critical and creative skill, liftime learning, communication skill, team work, adaptation to changes, and self-evaluation (Khoiri et al., 2013). In PBL, the realworld problems is used to motivate the students through the problems (Farhan & Retnawati, 2014). When solving the problems, there will be information exchange between student and other students so that the problems can be overcome. Teachers act as facilitators to direct the problems so that the students' discussion is focused on the solution (Wulandari, 2013). According to Hartini (2014), there is significant influence of creatif thinking on students' learning outcomes when Problem-Based Learning is implemented.

The development of science curriculum especially Biology curriculum aims to develop student`s thinking skills, specifically critical thinking. Critical thinking skills is the ability to interpret data, make inferences, explain information clearly, analyse, and evaluate. However, student's critical thinking skill is not yet fully developed. Therefore, based on the demands of the 21st century, especially creativity and critical thinking, it is necessary to develop learning activities in schools that are able to enhance student's skill in order to achieve 21st century skills. Learning activities that are relevant to learning in the 21st century are project-based learning and problem-based learning. Both models of learning are equally presented issues brought from the real world. Authentic issues presented at the beginning of the lesson are made into problems that must be solved by students either individually or groups.

Implementation of project-based learning in Biology learning can be done by conducting project-based learning syntax written in lesson plans. The syntax of project-based learning by Bender (2012) are 1) introduction and team planing the project; 2) initial research phase in term of gathering information; 3) creation, development, initial evaluation of presentation, and prototype artifacts; 4) second research phase; 5) final presentation development; and 6) publication of product or artifacts.

In addition, project-based learning and problem-based learning models can be used to develop 21st century skills. Problem-based learning is a teaching model using problems as a main focus for developing problem-solving skills, materials, and self-organization (Kauchak & Eggen, 2012). The problems used in this model of learning are real world problems (Arends, 2007; Fogarty, 1997). Problems encourage students to share knowledge, negotiate alternative ideas, seek information, and construct arguments to support established solutions (Sawyer, 2014).

Problem-based learning can be applied in learning Biology by following syntax of the learning model. Problem-based learning begins with 1) problem orientation; 2) organizing students to conduct research; 3) assisting independent and group investigations; 4) developing and presenting artefacts; and 5) analysing and evaluating problem solving process (Arend, 2007). During the learning activities, teachers play a role in providing problems, asking questions, and facilitating investigations and dialogue.

The material used in this research is respiratory system including competence 3.8 and competence 4.8. Competence 3.8 mentioned that students are required to analyse the relationship between the structure of the respiratory system and its relation to bioprocess and disfunction that can occur in the human respiration system. In competence 4.8, it is added that students are also trained to present the analaysis result from the effect of air pollution to the respiratory disorder based on literature review.

Respiratory system material is choosen as a material in this research, because it is adjusted to the research context which is located in SMA Negeri 1 Temanggung. According to data from Directorate General of Plantation in 2014, Temanggung Regency is one of the largest regency that has tobacco (*Nicotiana tabacum*) plantation in Central Java Province. Temanggung Regency has 15,730 Ha of tobacco plantation. Harvested reaches 12,587 Ha. Tobacco production reached 6,923 tons and productivity reached 550 Kg/Ha.

Aside from being a tobacco producer, data from the Central Java Provincial Health Office (2014) shows that in 2014, there are several respiratory system disease caused by bacteria or infection, such as tuberculosis and pneumonia.

Problems used in project-based learning and problem-based learning are associated to respiratory system. By learning using project, students are faced with the essential question of how activities affect human lung capacity and how to reduce smoking habits. Based on information obtained by students from various sources during the learning activities, students are asked to design and test tools to measure the lung capacity and also make posters to reduce cigarette consumption.

In problem-based learning, students are faced with problems in the respiratory system associated with smoking habits. Students will investigate the influence of cigarette smoke and cigarette content by doing a simple experiment. After investigating and analysing the results of the investigation, students discuss diseases that may infect the respiratory system and seek a preventive solution from respiratory disease and then present the solution obtained. Therefore, students are expected to develop creativity and critical thinking skills by learning through project-based learning and problem-based learning.

After the observation, there were some problems found such as project-based learning and problem-based learning were rarely implemented in learning Biology at school. In addition, empirical evidence of the influence of project-based learning model and problem-based learning on the ability of students was limited. Moreover, student's creativity ability was low, shown by high tendency of similarity in doing tasks given by teacher. The critical thinking ability of the students was low, it was shown by the lack of analytical skills in answering questions asked by teachers during the learning activities.

Furthermore, the development of student`s creativity was low because of lack of encouragement. Learning activities in schools has not yet developed student's critical thinking optimally. More importantly, the development of creativity and critical thinking of students on learning Biology has not been a serious concern in the learning activities. Moreover, based on the previous research, learning biology using project-based learning can enhance learning activities and student's creativity (Yahya, 2014). It is also able to develop three learning domain namely cognitive, affective, and psychomotor (Sumarni et al., 2016).

The study aims to find (1) the effect of project-based learning and problem-based learning on student's creativity and critical thinking and (2) the difference effect of project-based learning and problem-based learning on student's creativity and critical thinking in respiratory system at SMA N 1 Temanggung.

This research is expected to provide benefits either directly or indirectly to teachers, students, and other researchers. Teachers can enrich the learning model such as project-based learning model and problem-based learning in Biology learning. Students can improve thinking skills, such as creativity and critical thinking, and also can apply the knowledge gained during the learning activities in everyday life. In addition, other researchers can get information about the effect of project-based learning and problem-based learning to student's creativity and critical thinking, so that it can be beneficial for further research.

METHODS

This research is quasi-experimental research using nonequivalent control-group design (Gall, et al., 2007). The quasi experimental design used in this research is non-equivalent control-group design. The research was conducted at SMA Negeri 1 Temanggung, Temanggung Regency, Central Java from January to February 2017. The population of this research is the entire class of IX grade of Mathematics and Natural Sciences Program which is divided into 7 classes. The sample of this research is 3 classes taken randomly from IX grade of Mathematics and Natural Sciences Program. XI MIPA 3 implemented project-based learning model, class XI implemented problem-based learning model, and class XI MIPA implemnted 5M learning model as a control group.

Data collected in this research consists of learning implementation data, student's creativity data, and student's critical thinking data. Learning implementation data were obtained from the observation sheet which was developed based on the lesson plan. The project-based learning model begins with 1) introduction and team planing the project; 2) initial research phase in term of gathering information; 3) creation, development, initial evaluation of presentation, and prototype artifacts; 4) second research phase, 5) final presentation development; and 6) publication of product or artifacts. Problem-based learning model begins with 1) problem orientation; 2) organizing students to conduct research; 3) assisting independent and group investigations; 4) developing

and presenting artefacts; and 5) analysing and evaluating problem solving process.

Student's creativity data and student's critical thinking data were obtained using the instruments of creativity and critical thinking. Aspects measured in creativity consist of unusual uses, sensitivity to science problems, the ability to develope the product, the ability in scientific imagination, creative problem-solving skills, experimental design abilities, and the ability to design products. Aspects measured in critical thinking consist of the ability to make interpretation, analysis, inference, evaluation, and explanation. To know the effect of project-based learning model and problem-based learning model to student's creativity and critical thinking, data were analysed using paired sample t-test. The test was conducted on two paired samples. Furthermore, to analysis two groups of data simultaneously, data were analysed using MANOVA. Before data were analysed using MANOVA. Data had to meet the assumptions test which consists of normality and homogeneity test.

Table 1. The Results of Descriptive Statistic on Student's Creativity

Descriptive Statistic Result	Experiment				Control	
	PjBL		PBL		5M	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Mean	44,01	70,38	46,85	59,77	35,40	59,45
STDV	11,45	11,38	11,69	16,05	14,46	17,07

RESULTS AND DISCUSSION

This research was conducted on respiration system material in XI grade. It was divided into 6 mettings. Based on observation, project-based learning and problem-based learning model were implemented accordingly to lesson plan. The learning activities was started with pre-test and ended with post-test. Pre-test was conducted to obtain student's creativity and critical thinking data before the treatment. In the end of learning activities, post-test was conducted to obtain student's creativity and critical thinking after the treatment. Both pre-test and post-test were implemented using the creativity test and critical thinking test that have been developed. Table 1 shows the results of descriptive statistics of students' pre-test and post- test of creativity.

Based on the data presented in the table, it can be concluded that the average on student's creativity increase in project-based learning class, problem-based learning class, and 5M class. The data of student's critical thinking ability was obtained from pre-test and post-test of student's critical thinking. Figure 1 shows the results of descriptive statistics of pre-test and post-test of critical thinking of students.

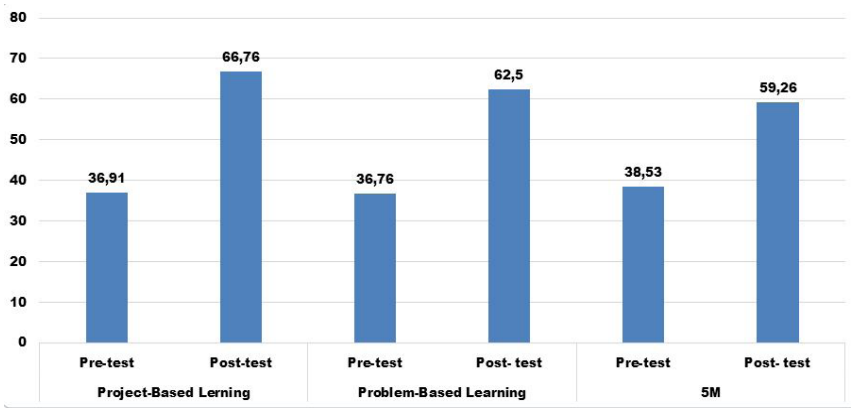

Figure 1. The Results of Descriptive Statistic on Student's Critical Thinking

Based on the results of descriptive analysis, it can be concluded that the average critical thinking ability of students has increased after following the learning activities with project-based learning model, problem-based learning model, and 5 M. Data analysis was conducted by comparing mean of each dependent variable measured in terms of student's creativity and critical thinking skills. The comparison of mean data before and after treatment aims to test the mean equality between experimental class in project-based learning and problem-based learning, and control

class by using 5M learning on student's creativity and critical thinking simultaneously. The mean comparison is also conducted only on the mean post-test of student's creativity and critical thinking skills.

The comparison of post-test mean aims to test the hypothesis of the effect of each learning model on each dependent variable; creativity and critical thinking skills. The mean comparison aims to determine the comparison between the effect of project-based learning model and problem-based learning, the comparison between project-based learning and 5M, and the comparison between the problem-based learning model and 5M to the student's creativity and crtitical thinking skillls on the learning of Biology especially regarding respiratory system.

To know the effect of learning models; project based learning model, problem-based learning, and 5M to creativity and critical thinking skill of students, paired-sample t-test was conducted. This test was performed in order to know the difference between studen't creative and critical thinking skills before and after the treatment. Table 2 shows the result of paired sample t-test

Table 2. The Result of Paired Sample T-Test

Dependent Variable	Learning Model	Sig.
Creativity	PjBL	0,000
	PBL	0,000
	5M	0,000
Critical Thinking	PjBL	0,000
	PBL	0,000
	5M	0,000

Based on the results of paired sample t test, the result, both creativity and critical thinking skills in project-based learning model, problem-based learning model, and 5M show significant difference, which was indicated by significance value 0,000 (Sig. = <0.05). This means that the average value of pre-test with post-test is different. It can be concluded that both project-based learning and problem-based learning affect student's creativity and critical thinking.

To investigate the difference of learning effect using project based learning, problem-based learning, and 5M model on student's creativity and thinking skill, multivariate test was conducted and continued by univariate test to determine which variables contribute to the overall difference. Prior to the multivariate test, a prerequisite test was conducted including normality and homogeneity tests. Based on the results of normality test with Kolmogorov-Smirnov on pre-test creativity and critical thinking results, it showed that the data of pre-test creativity result of the three groups is distributed normally showed by significance value above 0,05. Based on homogeneity test results based on Box's Test of Equality of Covariance Matrices shows that pre-test data has homogeneous population data variance indicated by a significance value greater than 0.05.

Multivariate test was conducted to know the effect of learning model that was project-based learning, problem-based learning, and 5M to creativity and critical thinking ability of students simultaneously. Multivariate tests were performed for post-test value of creativity and critical thinking. The multivariate test used was Hotelling's Trace statistics. Hotelling's Trace was used for two groups of dependent variables. In this research there were two dependent variable, such as creativity and critical thinking. Table 3 presents the results of multivariate statistics with the Hotelling's Trace test

Table 3. The Results of Multivariate Statistics

Effect	Value	F	Sig.
Learning Model	0,126	3,052	0,018

The result of multivariate analysis using Hotelling's Trace test showed value equal to 0,126, and $F_{Calculate}$ equal to 3,052. The value of significance showed the number 0.018 which is smaller than 0.05 so that H_0 is rejected. Based on the results of the analysis it can be concluded that there is an average difference between project-based learning model group, problem-based learning model, and 5M toward creativity and critical thinking ability. After doing multivariate test on result of post-test of creativity and critical thinking ability, then conducted univariate test. Univariate test is conducted on post-test value of student's creativity and critical thinking skills in order to analyse each variable. Table 4 shows the result of univariate test.

Table 4. The Result of Univariate Test

Test of Between-Subjects Effects			
Source	**Dependent Variable**	**F**	**Sig.**
Learning Model	Creativity	5,812	0,004
	Critical Thinking	1,885	0,157

Univariate test analysis on post-test value shows that for dependent variable of creativity show $F_{Calculate}$ equal to 5,812 and significance value less than 0,05 (Sig = 0,004). These values indicate that the three models of learning have an influence on the creativity of students positively and significantly. As for the ability of creative thinking, univariate test results show $F_{Calculate}$ value of 1.885 and significance value greater than 0.05 (Sig = 0.157). These values indicate that the three learning models have no significant effect on creativity in a positive and significant way.

After conducting univariate test, the effect of each model of learning to student's creativity and critical thinking was tested. The tests were performed on each mean of the creativity and ability of the students' post-test by using the Tukey test. The result shows that the significance value of project-based learning model and problem based learning model is smaller than 0.05 (Sig = 0.012) which means that there is a significant difference of creativity average on both learning models. The result of the analysis for the project based learning model and 5M shows the significance value less than 0.05 (Sig = 0.010) which means that there is difference of creativity average of both learning model. The test results on the model of problem-based learning and 5M shows a significance value above 0.05 (Sig=0.996) which means that there is no difference in the creativity average of the two learning models.

Based on the results of Tukey's test analysis for the effect of learning model of critical thinking, it is also known that the significance value for project-based learning model and problem-based learning model is greater than 0.05 (Sig = 0.516). The significance value means that there is no difference in the average of critical thinking of both learning models. The significance values greater than 0.05 also occur for project-based learning and 5M (Sig.=0.134) and problem-based learning and 5M (Sig.=0,682) models. The value of significance means that there is no difference in the average of critical thinking in the learning models.

Project- based learning is one of the suggested learning models to be implemented in learning Biology. It can encourage students to create project whether individually or in groups. Other learning model such as problem- based learning are also proposed to be implemented in Biology learning. These alternative learning models provide opportunities for teachers to choose a model of learning accordingly to the characteristics of students and materials. The questions for measuring creativity is included into divergent thinking questions. Divergent thinking questions tend to ask for varied or non-fixed answers rather than only one alternative answer. In this research, questions are arranged based on the local issues. According to Runco (Kaufman & Sternberg, 2011) contextual questions are able to illustrate the behavioural habits of students on the actual conditions.

Based on the data, student's creativity skills in project-based learning class has a higher average post-test than students in problem-based learning class and 5M class. The higer average is influenced by the experience of learning activities experienced using project-based learning model. Creativity in the context of learning begin with the process of sensing and observing problems, making conjectures about problems, assessing, and testing allegations or testing hypotheses. The next process is to change and conduct the testing, and then deliver the results (Torrance, 1979).

Project-based learning begin with 1) introduction and team planing the project, 2) initial research phase in term of gathering information, 3) creation, development, initial evaluation of presentation, and prototype artifacts, 4) second research phase, 5) final presentation development, and 6) publication of product or artifacts (Bender, 2012). The learning of project-based learning that is carried out refers to the driving question (Bender, 2012; Thomas, 2000) which is closely related to the respiration material. Driving question helps students to develop the ability to find solutions actively. The driving question used was how human activities influence the performance of the respiratory system and how efforts can be made to encourage people to reduce smoking habits. Driving questions in the begining of the lessons are broad and not specific, so that students need to make discoveries and innovations by adding questions to make the project more specific.

At the beginning of learning with project-based learning, there is an anchor that is used to be an introduction to the project and also attracts students to the project (Bender, 2012). The anchor used in this lesson was a journal and article as references to make a simple instrument to measure the lung capacity and also posters. During project-based learning, students were encouraged

to identify problems that affect lung frequency and lung capacity. After identifying problems, students developed and designed solutions by designing simple instrument to measure lung capacity. The instrument was made to prove that human's lung capacity was influenced by several factors. Students worked and conducted experiment to measure lung capacity in a group. After conducting experiment, student made report and also presentation. All of those activites were student- centered, students determined amd created their own projects in group.

During the learning activities, the role of the teacher is as a facilitator and accompanies the students (Thomas, 2000). Teacher gives advice and feedback in order to improve the projects. Feedback is also obtained from other students or other groups when the project design is presented. Peer-evaluation and feedback from teachers provide opportunities for students to make reflection and improvemnet on their projects (Bender, 2012; Kean & Kwe 2014). Students work together in groups to complete the project design (Bender, 2012; Mioduser & Betzer, 2007). Students also create a schedule to finish the planned project. After product had been finished, students present the product and also the posters.

The first project in project- based learning was making simple instrument to measure lung capacity. During the process of making instrument, students were trained to be sensitive to the problem that every person gas differnt lung frequency and lung capacity. The differences are caused by various factors. Students were trained to find out and prove the differences of lung frequency and lung capacity. Teacher guideed students in designing the instrumet. Students were also trained to design products using simple materials and apply scientific principles to obtain accurate measurement results.

The second project was making poster regarding to the danger of smoking. In the second project the students were trained to be sensitive to the smokers in the community. Students were encouraged to create posters as a preventive effort in order to invite the community to avoid the habit of smoking. Poster was made by considering some aspect such as originality, poster component, language, and information accuracy displayed in the poster. Projects can be very beneficial in developing cooperative skills (Collette & Chiappeta, 1989). Peer- assessment shows that the students can work together with the group well. This is indicated by the value given to the questionnaire distributed to the student. In addition, project work actively encourages students to gather more in-depth knowledge of respiratory material and sharpen skills in research (Kean & Kwe, 2014).

Project-based learning and problem-based learning have different characteristics from various aspects. According to Savin-Baden & Major (2004) differences in project-based learning and problem-based learning can be assessed based on knowledge organization, the form of knowledge, the role of students, the role of the teacher, and the type of activity undertaken during the learning activities. In project-based learning the assignment has been arranged in such a way by teachers (tutor-set or structured tasks), while on problem-based learning the problem is presented openly (open-ended situations and problems). In project based learning knowledge form and practical, while in problem-based learning in the form of contingent and constructed.

The role of teachers and students during the learning activities with project-based learning and problem-based learning are also different. In project based learning the role of teacher as tasks setter and project supervisor and the role of students as completer of project or member of project team that develop solution and strategy. In problem-based learning the role of students is as active participants and inventors and have their own learning experience, while the role of teachers is to provide opportunities for students to learn.

Activities during the learning activities between project-based learning and problem-based learning can also be distinguished. In the project based learning, learning activities focus on problem solving activities and problem management. In problem-based learning, learning activities focus on developing strategies to facilitate teams and learning. Project-based learning conducted in this research was the representation of ideational learning. Ideational learning is a learning that relying on the aspirations of students. Learning is open-ended developing domain that supports uniqueness and expects different learning outcomes (Dettmer, 2006). Projects assigned to students give students the freedom to design and develop products accordingly to their expectation, so that one group and another have different results.

Project-based learning is a constructivistic learning that students can learn maximally if able to construct artefacts so that students can be more involved in learning activities (Grant, 2002). Students learning in project- based learning class

were able to make a good report which consists of title, purpose, theory, tools and materials, procedure, results, discussion and conclusion. In addition, students are able to collect information about the dangers of smoking and put in into the poster as well. Student's creativity can be developed through learning that develops the imaginations by providing opportunities for creative writing and also problem solving that offers a variety of different perspectives.

Learning process provides enough time for students to seek and explore the information needed during the learning activities by utilizing the technology (Burke, 2007). Thus, learning process is expected to enhance aspects of scientific creativity that include aspects of unusual use, sensitivity to science problems, the ability to improve usability and product value, the ability of scientific imagination, creative problem-solving skills, experimental design skills, and designing product. Students learn using problem-based learning have lower creativity average than students in project-based learning class. Learning problem-based learning models are effective when used for long-term learning and improving student's performance, so students show less than optimal results when tested on tests for short term knowledge retention (Strobell & Barneveld, 2009).

Science learning can be used to develop student's higher-order thinking skills such as critical thinking. Critical thinking is a complex thinking process that consists of interpretation, analysis, inference, evaluation, explanation, and self-regulation (Facione, 2011). Critical thinking is referred to as higher-level thinking (higher-level thinking/higher-ordered thinking), which includes the top three capabilities in Bloom's Taxonomy: the ability to analyse, synthesize, and evaluate (Bookhart, 2010; Moore & Stanley, 2010). Development of critical thinking ability can be conducted by open- ended question or divergent question. Open- ended questions are questions that expect many possibilites of correct answers (Collete & Chiappetta, 1994; Subali, 2013). One of the learning models that develops critical thinking skills especially on science is problem-based learning. Problem-based learning presents issues that encourage students to not only thinking about the cause but also thinking about how to solve the problem (Strobel & Barnevel, 2009).

Result shows that there is no significant difference in the studen's critical thinking skills in project-based learning, problem-based learning, and 5M. The results can be caused by many factors, such as learning activities. The learning activities implemented in Biology learning using problem-based learning are conducted accordingly to problem- based learning by Arends (2007). Learning begun with the first phase of learning, which was problem orientation. The second phase was organizing students to research. Students made group and distributed learning tasks according to the issue. The third phase was an independent or group investigation. Teachers encourage dstudents to get the information needed to find solutions to problems by carrying out experiments. After conducting the experiment, students developed presentation about the investigation result and also presented the results of discussions about smoking-related diseases and its prevention. During the discussion, teacher guided student to discuss and give the clarification. At the end of the learning process, teacher helped students to make a reflection about learning activities that had been done.

In problem-based learning, students presented the problem about the effect cigarettes content on human's health. Students were asked to find the cause why the cigarette ingredients are dangerous by investigating and seeking information from various sources. Students then discuss one of the diseases caused by the content in a cigarette that consists of causes and efforts to overcome and prevent the disease. The problems used during the learning activities was an authentic problem. The issues raised in this study was issues related to the impact of substances contained in cigarettes to health.

Problem-based learning is one of the learning models that able to develop student's critical thinking skills. At the beginning of learning, students are faced with incentive problems (Arends, 2007). In this research, problems were presented in the form of articles and video. The problems presented were related to real life problems regarding to problems caused by smoking. The problem is ill-structured that expect more than one solution (Tan, 2009).

During the learning activities the student is guided by the teacher to carry out authentic investigations (Arends, 2007). Investigation is conducted by carrying out a simple experiment. Investigation aims to seek information from the problems presented, because the information presented at the beginning of learning is still limited (Tan, 2009). A simple experiment conducted by students consists of two kinds of experiments

conducted at the fourth meeting. The first experiment was an experiment simulating the danger of cigarette smoke against the respiratory organs. Students used three kinds of cigarettes which were filtered cigarettes, unfiltered cigarettes, and homemade cigarettes. The lungs were simulated using white cotton. Students burnt cigarettes and observe the yellowish stain on cotton. Students then assumed that the more yellow stains on cotton, the more substances in the cigarette that will enter the human lungs.

The second experiment was the effect of tobacco content on the embryo. The embryo used in this experiment was the green bean embryo. Experiment was conducted by growing seeds on a medium that has been previously given tobacco water. In addition, students also grew the seeds in water as a control. Students then observed the growth of seeds for 4 days in a row and saw the difference. After conducting group investigations conducted by experiment, students made report and conducted the discussion to find out the relationship between the experimental results and the issues. The results of group discussions were presented. Students worked together in groups during learning process (Arends, 2007, Hmelo-Silver, 2004), while teacher played a role as a facilitator (Strobel & Barnevel, 2009).

During problem-based learning, student's critical thinking skills can be trained and developed. Mergendoller, Maxwell, & Bellisimo (2006) states that in problem-based learning teachers train students to carry out further research and discovery, but their assignment is not determined by the teacher, so students are freed to design and develop experiments through investigation. During the process of designing the experiment, students are trained to construct questions in order to construct the objectives of the experiment, determine the independent variables and the dependent variables in the experiment, write down the experimental results, and draw conclusions from the experiments. Students who participate in project-based learning have the opportunity to construct their own knowledge, compare it with other students and also select their knowledge while other students collect learning experiences. In addition, students who participating in problem-based learning are able to store knowledge longer, identify causal relationships, and transfer the concept to new problems (Savin-Baden & Major, 2004).

CONCLUSION

The results reveal that (1) project-based learning and problem-based learning affect student's creativity and critical thinking, (2) there is a difference effect of project-based learning and problem- based learning on student's creativity, and (3) there is no difference effect of project-based learning and problem-based learning on student's critical thinking.

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