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Comparing Student Creativity Skills in Experiment-Based and Project-Based Science Learning

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Abstract

This study aims to determine the comparison of students' creativity skills in experiment-based science learning and project-based science learning. This research is an experimental study with a posttest only control group design. The population of this study was class VII SMPN 2 Sugio, totaling 157 people (from class VII-A to VII-F). The method of obtaining data in this study is the method of observation and documentation. Methods of data analysis were carried out by testing for normality and homogeneity, as well as testing hypotheses by using independent sample t-test with the help of SPSS 18 for Windows. From this research it can be concluded that there are differences in the creativity skills of students in project-based learning and experiment-based learning, where the average value of creativity skills in project-based learning is greater than the average creativity skills in experiment-based learning.

Keywords: creativity skills, experiment, project, science learning

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INTRODUCTION

The emergence of the era of the industrial revolution 4.0 indirectly changes the paradigm of civilization, where the development of the quality of human resources is prioritized over the development of natural resources. This certainly causes the world of education to be motivated to make various efforts to improve the quality of human resources, which in this case the focus is on developing the quality of students. Through education, it is hoped that the main competencies needed in the era of the industrial revolution 4.0 can be possessed by students so that they are able to overcome various problems that arise in the future.

Referring to PISA data 2015 (OECD, 2016), the performance of Indonesian students in science is still low. This is in line with the findings of the PIRLS in 2006 which stated that the literacy competence of Indonesian students was very low and placed Indonesia in the 41st rank of 45 countries surveyed. In the last 20 years since PISA released the results of the scientific literacy skills of students around the world, Indonesia has always been at the bottom of the list. This shows that the quality of science learning in Indonesia is far below that of OECD member countries (Dadi Setiadi, 2014). Paying attention to the difficulties felt by students, one solution is to vary the learning models or methods that direct students to learning that helps in developing their potential (Ariana, et.al, 2020).

The 21st century learning skills are the skills that students must have to answer the challenges in this era of globalization. Trilling & Fadel is supported by the opinion of the US-based Partnership for 21st Century Skills which categorizes several learning skills needed in the 21st century known as "The 4Cs" (P21, in Zubaidah, 2016), including communication,

collaboration, critical thinking, and creativity. Of the four learning skills, creativity is one of the skills needed today, because by thinking creatively students are able to produce various possible answers or ideas that are useful in finding solutions to problems (Indriana, Arsyad, & Mulbar, 2015). Schools as educational institutions have the responsibility to develop creativity skills through learning activities.

Science is one of the subjects that always exist in schools, consisting of two components, namely a process and a product. As a natural science product, it consists of a collection of knowledge consisting of facts, concepts, principles and laws about natural phenomena. Meanwhile, as a process, IPA is one of a structured and systematic series carried out to find concepts, principles, and laws regarding natural phenomena (Rati, et.al, 2017). The goals of science education include knowledge and understanding, exploration and discovery, imagination and creativity, attitude and science, and application (Mariana & Praginda, 2009). The special characteristic in science material is studying factual natural phenomena, either in the form of reality, or events and cause-effect relationships (Wisudawati & Sulistyowati, 2014). Science is closely related to nature, making science subjects a difficult subject for students because they are abstract. For this reason, understanding science subjects requires a positive attitude from within students. But in addition to instilling a positive attitude in students, it is also necessary to instill the character value of student learning creativity, because learning creativity is important factors that can help students understand the concepts in science subjects (Siregar, 2020). Creativity involves a set of attributes (like self-confidence, desire for achievement, sensitivity) and thinking skills (like fluency, mental flexibility, imagination) (Fieldz & Bisschoff, 2018). That is why learning creativity is needed to support students in understanding science concepts.

Students' creativity skills are influenced by the learning that is carried out (Pamungkas, et. al, 2017). According to Hu & Adey (2002), the way to stimulate students' creative thinking is by learning that is free, open, and positive. Project-based learning is a type of learning that organizes students to build their knowledge independently through investigations and discussions to solve problems in order to achieve planned targets (Tseng, et al., 2013; Jagantara, et al., 2014). Project-based learning is one of active learning by involving students independently with the criteria that in this learning it will also increase students' thinking power towards metacognitive such as critical thinking about projects that will be worked on through problems found by students. This project-based learning is authentic, so indirectly this learning will involve learners in constructive investigations. Active learning activities are closely related to individuals who behave creatively in expressing their ideas. Individual creativity can lead to behaviors such as developing original ideas, attitudes in determining their learning strategies (fluency), and usually creative students also tend to be more interested in complex and detailed things (elaboracy) and flexible in dealing with a problem (Munandar 2009).

Based on the results of interviews with two science subject teachers at SMPN 2 Sugio, information was obtained that most of the seventh grade students had not shown high enthusiasm in science learning, such as being less active in asking and responding to questions and not being skilled in exploring laboratory equipment. In addition, when given various questions that train higher-order thinking skills, students tend to answer them conceptually or theoretically (textbook oriented), not developed according to their opinion or based on their experiences. All the characters that appear show that students still have low curiosity and do not dare to try new and risky things. Therefore, it is necessary to investigate further, what learning strategies are most relevant and really able to stimulate and increase the creativity of students.

According to Rati, et. al (2017), there is a significant effect of project-based learning models on student creativity. Project-based learning models can increase students' self-confidence, creativity to learn, creative abilities, and self-admiration. The same thing was done by Luthvitasari, et. al (2012) in a study on the implementation of project-based physics

learning on students' creative thinking skills, it was found that the project-based learning model had an influence on improving the creative thinking skills of vocational students. This suggests that students' creativity skills can be measured and improved through project-based learning.

In addition to project-based learning, experiment-based science learning is also believed to improve creativity skills in students, such as research conducted by Busyairi & Sinaga (2015) that experiment-based learning can significantly improve cognitive abilities and creative thinking skills in student problem solving compared to the application of learning conventional. The results of research conducted by Sriatun, et. al (2018) also showed that there was a significant increase in students' creative thinking skills after the problem based learning model was applied in the black principle experiment. This also shows that apart from project-based learning, learning with the experimental method is also able to improve students' creativity skills.

Experiment-based learning is a good learning strategy for students to develop manipulative skills, skills hands-on and mind on, because students are challenged to be active in solving problems, thinking critically and creatively in uncovering facts, building concepts, and applying principles to become more meaningful (Sukaesih, 2011). Strengthening the function of experiment as a laboratory activity in learning plays a role in strengthening the concepts presented in lectures, including those stated by Dwiyanti (1999) which states that the function of experiment is: (1) clarifying the direct concepts presented in class through direct contact with tools, materials or events nature, (2) improving students' intellectual skills through observation or information (theory) in a complete and selective manner containing practical problem solving, (3) training students in solving problems, (4) training and designing experiments, (5) interpreting (interpretation)) data and (6) fostering a scientific attitude. So, indirectly, experiment-based science learning can shape/increase student creativity. To determine the extent of the effectiveness of learning that can increase student creativity, this study aims to compare students' creativity skills using experiment-based and project-based science learning here.

METHOD

This research is an experimental study with a posttest only control group design. The population of this study was class VII SMPN 2 Sugio, totaling 157 students (from class VII-A to VII-F). In this study, there were two classes, each of which was randomly selected as a sample, namely 23 students for experiment 1 (VII-D) for science learning with experiment and 23 students for experiment class 2 (VII-C) for learning science with projects. This research was conducted in the odd semester of the 2020/2021 school year.

The stages carried out in this study are: 1) determining the population and research sample, 2) testing the validity and reliability of research instruments, 3) providing treatment in the form of experiment-based learning in the experimental class 1 (VII-D) and project-based learning in the experimental class 2 (VII-C), 4) conducted a creativity assessment for the two lessons, and 5) analyzed the data from the assessment results.

The data acquisition method in this study was mostly carried out by the observation method. The observation method is carried out by observing student activities that show creative criteria in both experimental and project activities. In experimental-based learning, the creativity criteria measured include: 1) fluency, which consists of carrying out all experimental procedures and calibrating measuring instruments and reading measurement results; 2) flexibility, which is shown through activities to overcome problems in the experiment, 3) elaboration, which is shown through writing down all measurement results; and 4) originality, which consists of writing down all the results of observations and measurements and writing down the results of data analysis. While in project-based learning, the creativity criteria measured include: 1) fluency, which consists of carrying out all project procedures and using measuring tools in project activities, as well as the work function of

project products; 2) elaboration, which consists of writing down all the results of observations and measurements, reports written according to a predetermined format, as well as tools and materials used in accordance with the project plan and supporting the functioning of the project's products; and 3) originality, which consists of writing down all observations and measurements as well as neat and attractive project results that do not reduce the functionality of the product.

Observational data were collected using performance appraisal sheets for experimental activities and project appraisal sheets for project activities. In order for the data obtained to be valid, before being used as a data collection instrument, the performance appraisal sheet and project appraisal sheet are validated first through expert validation tests. Expert validation results show that the average AVI (Aiken's Validity Index) for all aspects tested in the two instruments (aspects of format, language, and content) are 0.925 and 0.95, respectively, where the error level is 1% or 5%. These results have exceeded the specified validity index limit (in terms of the number of indicators, validators, and scales). This shows that the validity of the performance appraisal instruments and projects used has a fairly high index. In addition to validity, the reliability of the two instruments was also tested. The results show that the two instruments have a reliability score (Cronbach Alpha r value) of 0.602 and 0.785, respectively, where when compared with the r table value (adjusted for the number of samples), both show greater results. This shows that the reliability of the performance appraisal instruments and projects used is reliable and feasible to be used as a data collection tool. In addition to the observation method, another method used in obtaining this research data is the documentation method. Documentation is used to obtain data related to the number and identity of students who are the population and samples, as well as the value of students' skills in previous learning which is used as a reference as initial ability.

Methods of data analysis were carried out by testing for normality and homogeneity, as well as testing hypotheses. Normality and homogeneity tests were carried out to determine the distribution of data normality and data variance between the two experimental groups. Hypothesis testing is done by using an independent sample t-test with the help of SPSS 18 for Windows.

RESULTS AND DISCUSSION

This research is an experimental study that aims to compare the creativity of students in science learning through practical activities with the creativity of students in science learning through project activities. The assessment of creativity was carried out on each of the 23 students in the two experimental classes with a maximum score scale of 100. The data collection instrument used was valid and reliable, because before use it was tested for validity and reliability.

Data analysis in this study was divided into 3 stages, namely normality test, homogeneity test, and comparison test. Based on the results of the analysis that has been carried out using the Kolmogorov-Smirnov formula, data shows that the population in the study is normally distributed with a probability value (Sig) for each group (experiment = 0,152 and project = 0,200 in the Kolmogorov-Smirnov column) above 0,05 likewise in homogeneity testing. It is known that the probability value (Sig.) For the based on mean is 0,095 or above 0,05. Thus it can be concluded that the variance comes from a homogeneous group. This indicates that the sample has the same condition.

With the same conditions, data analysis can be continued to the hypothesis testing stage. After getting different treatments, namely science learning through experiment activities and science learning through project activities, it was seen that the creativity skills of students were quite different. The results of calculations using the independent sample t-test through SPSS, show the value of Sig. (2-tailed) 0,112> 0,05. This was supported by the average value of students 'creativity skills in experiment-based science learning, which was 83,565 and the average value of students' creativity skills in project-based science learning

was 86,130. The difference in the mean score of -2,5652 shows that the creativity of students in project-based science learning is better than that of experiment-based science learning.

Table 1. Hypothesis Test Result

		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference
Creativity	Equal variances assumed	2.9	.095	-1.622	44	.112	-2.5652
	Equal variances not assumed			-1.622	40.794	.113	-2.5652

Table 2. Comparison of Mean Score

	Group	N	Mean	Std. Deviation	Std. Error Mean
Creativity	Experiment Based Learning	23	83.565	4.5510	.9489
	Project Based Learning	23	86.130	6.0701	1.2657

The better creativity skills of students in project-based science learning are caused by several things. First, project-based learning provides broad opportunities for students to convey ideas and ideas related to what products will be used as project results. Project-based learning involves students in the transfer of knowledge and skills through a process of discovery with a series of questions arranged in a task or project (Buck Institute of Education, 2007). In contrast to experiment-based science learning, where students must follow all the procedures listed in the experiment guide, students are not free to create and innovate in experiment activities.

The assessment of creativity in science learning through experiment activities was carried out on 20 students of grade VII SMP. The results of the assessment are analyzed as a percentage to determine the number of students who get a score of 1, 2, and 3 for each measured indicator.

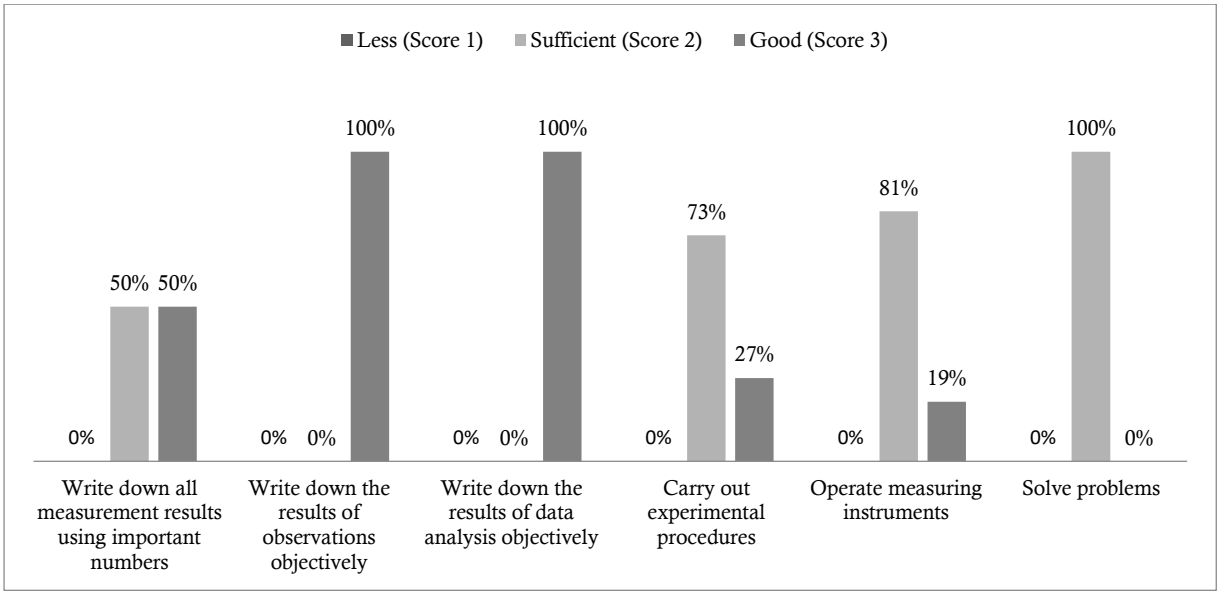

Figure 1. Percentage of students who scored 1, 2, and 3 on each of the creativity assessment indicators in experiment appraisal

Figure 2. Percentage of students who scored 1, 2, and 3 on each of the creativity assessment indicators in project appraisal

In Figure 1 it can be seen that for all indicators of creativity in science learning through experiment activities, no student got a score of 1. Most of the students got scores of 2 and 3 on each indicator. Especially in the activity of writing down the results of observations and analyzing data objectively, all students got a score of 3. This indicator is included in the aspect of authenticity in creativity skills. This shows that all students really show an open and genuine scientific attitude in experimental activities. The other 3 scores are also shown in the indicators for writing measurement results using significant figures, conducting experiments, and operating measuring instruments. These indicators include aspects of fluency and elaboration. The score of 2 which is included in the sufficient category still dominates the indicators for carrying out experimental procedures, operating measuring instruments, and overcoming problems. These three indicators are included in the aspects of creativity, fluency and flexibility. The lack of experimental methods in stimulating the three indicators also appears in the research conducted by Assriyanto, et. al (2014) who explained that practicum, some students seemed to experience boredom where many students chatted outside the material. During practicum students carry out activities according to practicum instructions, but during presentations, students' enthusiastic observations are less visible, because students tend to be limited to answering questions. In this practicum-based learning, students only experience it directly without trying to find the concept. Students are more passive because students only solve problems according to the directions and guidelines given by the teacher without being able to develop their knowledge and without thinking of their own steps to solve the problem. The same thing happened in this study. When learning with the practicum method is carried out, students tend to carry out activities according to practicum instructions only. If there is a problem, students tend to depend on the teacher and do not try to find a solution together with their group of friends first. However, if you look at the overall score, practicum-based learning is still able to develop students' creativity. This is in line with research conducted by Sriatun, et. al (2018) which explains that in the implementation of practicum activities students can learn by doing, work alone to find and prove the truth of the theory based on the results of practicum conducted by students. Through this kind of activity, students' creative thinking skills will be able to develop. This is also in line with the findings expressed by Fasco (2001), namely that creativity can be developed if students are given tools and materials to encourage experimental and production activities, and provide time for students to process, discuss, and conduct experiments.

In Figure 2, it can be seen that for all indicators of creativity in science learning through project activities, there are no students who get a score of 1. Most students get a score of 2 and 3 on each indicator. Especially in the activity of analyzing data according to relevant and objective theories, all students get a score of 3. This indicator is included in the aspect of originality in creativity skills. A score of 3 is also quite a lot obtained on indicators of creativity such as conducting experiments, using measuring instruments, testing project results, quantity of data sources, and product aesthetics. All these indicators fall into the aspects of fluency, elaboration, and originality.

This is in line with research conducted by Ummah, et. al (2019), which shows that in project-based learning, students' creativity can be seen from aspects of originality, flexibility, and novelty. In the aspect of flexibility, students can design various types of learning media as desired. For example, the resulting geometric product is developed using bamboo sticks as ribs and clay as knots. In this study, the flexibility aspect can be seen from the product of the application of heat in the form of an eco cooler produced by students which was developed using nearby materials such as cardboard and used plastic bottles. While on the aspect of authenticity, it can be seen from the contribution of ideas / ideas from various students in one group which is then developed into a whole idea. In the aspect of novelty, all media produced are the result of development / adaptation of previously existing media. Likewise with other studies conducted by Hanif, et. al (2019), which explains that students who apply STEM project-based learning to the concepts of light and optics have good creativity in the dimensions of resolution, elaboration, and novelty. The results of creativity obtained as much as 76% included in the good category. Project-based learning enables students to research, plan, design and reflect on both project processes and outcomes. Project-based learning allows students to broaden their knowledge of a particular subject. The knowledge gained becomes more meaningful and learning activities become more interesting, because the knowledge is useful for him to better appreciate his environment and can be used to solve problems faced in everyday life (Fatmawati, 2011). For example, in this study, the project of making simple thermos, cooling pots, and eco coolers not only gave students insight into how the science concepts learned could be applied in solving everyday life, but also gave them experience to be sensitive to environmental problems that occur. surrounding. Thus, apart from being more creative, students will also be more motivated to find new innovations related to previous projects.

But even so, the differences in creativity skills shown by students either through experiment-based or project-based learning did not really show a significant difference (although in terms of creativity skills scores through project-based learning were better than experiment-based). This has been explained by Pramanawati, et. al (2016) in his research which explains that the higher the student's creativity, the higher the learning achievement achieved so that whatever learning method is used, students who have high creativity will have better learning achievement than students who have low creativity. Conversely, regardless of the level of student creativity, both high and low categories of students who are subject to project teaching will have better learning achievement than students who are subject to experimental teaching.

CONCLUSION

From this research it can be concluded that there are differences in the creativity skills of students in project-based learning and experiment-based learning, where the average value of creativity skills in project-based learning is greater than the average creativity skills in experiment-based learning. However, this difference is not too significant, because the creativity skills of each student are also influenced by learning achievement, so there may need to be further studies related to other factors that affect the creativity of students.

RECOMMENDATION

Based on the research that has been done, there are several things that need to be considered for further research, including: 1) in addition to practicum and project-based learning, students' creativity skills can be stimulated through various other learning strategies with a student-centered approach, 2) there are various dimensions other skills that can still be analyzed and compared, especially those belonging to the 21st century learning skills, and 3) student creativity cannot be formed only by applying one learning strategy in a single period of time, but continuously and continuously. In addition, it is also necessary to know the shortcomings that exist in this study, namely the assessment of creativity skills through practicum and project-based learning, which is mostly done by observation, causing the time required to take quite a long time considering the number of students in the class is quite large. Therefore, increasing the number of observers / assessors can be used as an alternative solution.

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