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Application of The PjBL-STEM Model to Natural Science Learning Devices to Increase the Creativity

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ABSTRACT

The study aims to determinate the project based learning (PjBL) model with the STEM approach in increasing the creativity of junior high school students. The research method used is a quasi-experimental. The design in this study is a one group pretest-posttest design. The population of this research is class VII in a state junior high school in Surakarta. The sample of this study was 44 students consisting of two classes, namely class VII G as the experimental class (22 students) and class VII H as the control class (22 students). The instrument used was a creativity test instrument consisting of 6 questions on the is the N-gain test. Based on the result of data analysis, it was obtained that the experimental class N-gain average was 0.59 with the medium category and 0.36 for the control class with the low category. The result of the t-test show that there is a difference in creativity between the experimental class using the PjBL model of science learning tools with the STEM approach and the class without using the device.

Keywords:
Project-Based Learning, STEM, Creativity, Environmental Pollution.

INTRODUCTION

The national education system entering the 21st century faces challenges in preparing the quality of human resources who can compete in the global era. Education is a necessity that must be possessed to improve human resources both in attitudes, knowledge and skills through teaching and training. Through human resources it is expected to be able to shape changes in the field of education in the future (Allivna & Mundilarto, 2019; Demirbağ, 2020; Eyong,Ugada & Aminu, 2020; Sejati, Saputro & Indriyanti, 2020; Utomo, Ubaidillah, Joyoatmojo, Yutmini & Suryani, 2019). Educational goals must be adapted and developed, the curriculum must be adjusted. Changes in the education sector at this time the government implemented the 2013 curriculum as the initial foundation in implementing learning in Indonesia. The 2013 curriculum provides new innovations in the world of education, including being able to shape the personalities of students to be more creative and innovative (Regulation of The Minister of Education and Culture, 2014).

Such educational goals can be seen from the implementation of education in schools, operationally it has not been pursued optimally. The objectives of education cannot be achieved properly this is due to the low ability of teachers to deliver and master learning material, the use of school facilities to support the learning process is very limited, and inadequate school facilities and infrastructure. Changes in the field of education are currently implementing the curriculum 2013 as the initial foundation in implementing learning in Indonesia. The 2013 curriculum provides changes to three core competencies that students must master in learning, namely attitudes, knowledge and skills, besides learning changes slightly in their approaches and strategies (Trianto, 2012).

The learning device is a means of supporting learning in detail which contains the competencies to be achieved. However, some teachers still experience difficulties in making learning tools, especially in formulating the objectives and indicators outlined in the lesson plans. The learning design follows the syntax of a particular learning model as a guideline and measuring tool for the achievement of student competencies (Prasetyo, 2015). Regulation of The Minister of Education and Culture Number 65 of 2013 concerning Basic and Secondary Education Process Standards explains that the preparation of learning tools is part of learning planning. The learning plan is designed in the form of a syllabus and lesson plans which refer to the standard content. The learning tools needed in managing the teaching and learning process can be in the form of a syllabus, lesson plans (RPP), teaching materials, student activity sheets, and assessment instruments.

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Creativity is an activity that requires new ideas skills (Asrori, 2012). Creativity has an important role for one's success in training and developing potential skills. The results of the initial test analysis of the percentage of students' creativity ability were low. This can be seen from the results of the average value obtained and the achievement of indicators based on the aspects of creativity, namely *fluecy* (26.25%), *flexibility* (28.75%), *elaboration* (38.75%), and *originality* (28.75%).) with low criteria. The initial analysis was carried out in order to determine the creativity ability of students in analyzing and answering questions.

The low factor of creativity is due to one of them, namely the use of real problem solving around students that does not exist. Research conducted by Afriana, *et al* (2016), shows that STEM-PjBL learning can increase scientific literacy and learning to attract, motivate, and form creative attitudes in students. The aspect of creativity is important in every lesson, so creative thinking is an inseparable part of producing something creative in solving problems in school. Given the importance of creativity for one's success, cultivating and training student creativity is a separate agenda in the school curriculum. This is in accordance with the mandate of the curriculum which states that the competency standards of SMP / MTs students in the skill dimension are having skills and acting creatively, productively, critically, independently, collaboratively, and communicatively through a scientific approach according to what is studied in educational units and other sources independently (Ministry of Education and Culture, 2016).

The application of a learning approach must be balanced with the selection of an appropriate learning model. The learning model in the 2013 curriculum emphasizes the development of students' ability to solve problems. The PjBL learning model through project work activities based on challenging questions and problems can improve the ability to design, solve problems, and provide opportunities for students to work independently through investigative activities (Wena, 2013). The project-based learning (PjBL) learning model or project-based learning model emphasizes contextual learning activities through exploration activities, so that students are given the freedom to plan learning activities by carrying out projects collaboratively to produce a product result (Rais, 2010). PjBL learning takes a project-based STEM approach by integrating STEM fields.

The use of the PjBL learning model involves project work so that students are able to work on constructing learning for later results produce products (Trianto, 2012). The application of STEM-PjBL provides new experiences for students in developing the potential for both motivation and interest of students. Research conducted by Jauhariyyah, *et al* (2017), states that STEM-based learning can train students 'abilities and talents to face 21st century problems. STEM is an approach to teaching by combining two or more subjects related to practice so that it can increase students' interest in learning (Kelly & Knowles, 2016). According to Moore, *et al* (2014), efforts to combine several or four STEM subjects into one lesson are based on the relationship between subjects and real-world problems. Sanders (2009) explains that STEM is an approach that explores two or more STEM subjects in school subjects. STEM is a learning approach that connects four fields, namely science, technology, engineering, and mathematics into a holistic whole (Roberts, 2012). In the STEM approach, students are required to always be active in class, both hands-on activity and minds-on activity.

STEM-PjBL provides students with experiences in solving problems in everyday life with experimental activities, so as to increase the effectiveness and interest in learning of students. The learning that is applied is considered useful because in STEM-PjBL students are invited to carry out meaningful learning in understanding a concept and exploring through a project activity, so that students are actively involved in the process. The STEM-PjBL learning process in guiding students consists of five steps, each step aims to achieve a specific process, namely *reflection, research, discovery, application and communication* (Laboy-Rush, 2010). Based on the descriptions and background explanations that have been described, the researcher is interested in developing application of the PjBL-STEM model to natural science learning devices to increase the creativity of the students. The learning tools will then be applied to environmental pollution material contained in KD 3.8 and 4.8 of the 2017 revised 2013 curriculum.

Situation of the Problem

The result of observations and interviews at a public junior high school in Surakarta indicated several problems that were the cause of students' low mastery of concepts. *First*, the teacher has difficulty in

compiling a lesson plan (RPP). *Second*, teachers have difficulty in compiling LKPD and assessment instruments. *Third*, the method used by the teacher in teaching still uses the lecture method and rarely does practicum due to limited tools and materials. Fourth, the KKM score is still very low below the value of 70, namely 68. *Fifth*, teachers do not use approaches, models or methods to develop students' mastery of concepts.

The results of observations and interviews show that the approach often used in learning is the scientific and contextual approach. The STEM approach is rarely used because teachers have difficulty using it in learning. The difficulty in using STEM in learning is that students do not understand the condition of the surrounding environment and relate it to learning. The PjBL-STEM model is difficult to use because it combines the project with learning materials, so it takes a long time. In teaching science, teachers have difficulty in matters related to scientific names.

Aim of the Study

The study aim to determine the *Project Based Learning* (PjBL) model with the STEM approach in increasing the creativity of junior high school students. The STEM-PjBL learning process in guiding students consists of five steps, each step aims to achieve a specific process, namely *reflection, research, discovery, application and communication*. The learning tools will then be applied to environmental pollution material contained in KD 3.8 and 4.8 of the 2017 revised 2013 curriculum.

METHOD

The research method used is a quasi-experimental. The design in this study is a one group pretest-posttest design. The population of this research is class VII in a state junior high school in Surakarta. The sample of this research is class VII G (as the experimental class) and VII H (as the control class), as many as 44 students in one public junior high school in Surakarta, consisting of 20 boys and 24 girls. The instrument used was a creativity test instrument consisting of 6 questions on the subject of environmental pollution.

Material

This initial design was carried out by compiling an initial draft related to the development of learning tools consisting of a syllabus, lesson plans, teaching materials, LKPD, and assessment instruments. At the design stage, the first draft or *draft 1* will be produced which will then be validated at the development stage. The validity of this device is obtained with a data collection instrument in the form of a validation questionnaire with a minimum score of 1 and a maximum of 4. A maximum score of 4 is given if the learning device is very relevant / very good, a score of 3 is for the relevant / good device, 2 for the device that is less relevant / less good , and 1 for learning tools that are not relevant / not good. The final result of the validator's assessment is written in the conclusion and suggestion column and marks one of the 3 choices listed.

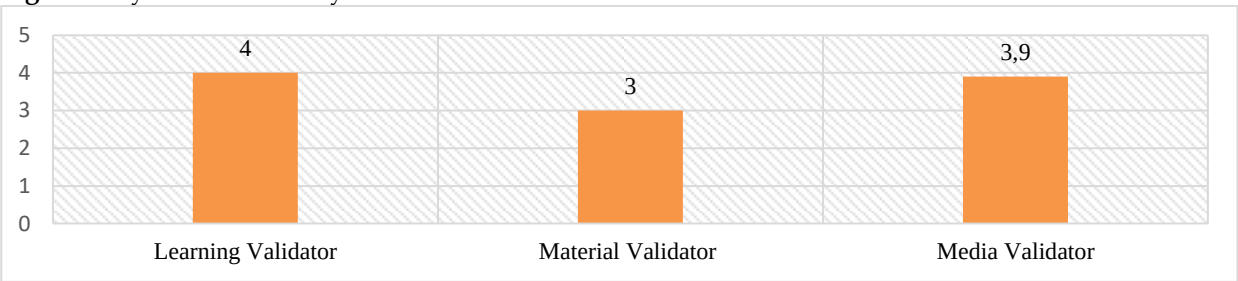
Data Analyses

Research and development carried out is a Research and Development (R&D) research, which is a type of research developed to produce a product. The products produced in this study are in the form of a *Project Based Learning* (PjBL) model of *Science, Technology,Engineering and Mathematic* (STEM) learning tools to increase the creativity of students. The process of calculating and processing statistical data will use the help of *IBM SPSS 23 software*. The data analysis stage consists of prerequisite tests, namely the normality test and homogeneity test, if the data is normally distributed and homogeneous, then a hypothesis test is carried out, namely the Independent Sample t-Test to see whether there is a difference. the creativity abilities of students.

FINDINGS

The results of the feasibility assessment of the syllabus by expert validators, among others, from learning experts giving a score of 4.00, material experts giving a score of 3.00, and media experts giving a score of 3.9, was presented in Figure 1.

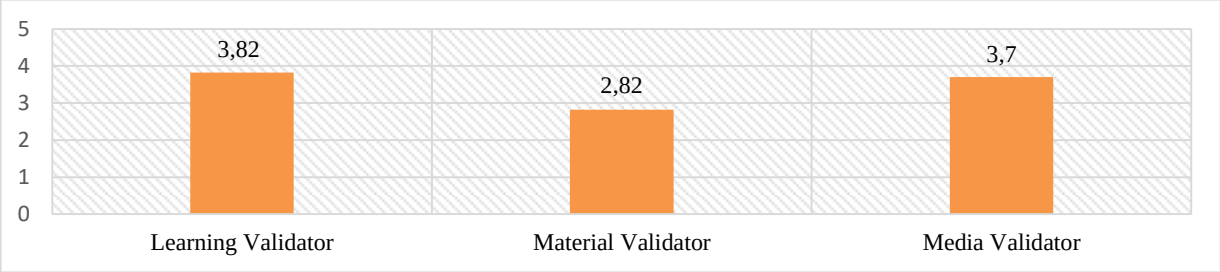
Figure 1. Syllabus Feasibility Test



The average rating of the three experts is 3.63 with the conclusion that this score falls into the very feasible category. Thus, based on the feasibility test above, that the result of one product from the learning device in the form of a syllabus is suitable for use in learning.

The result of the feasibility assessment of each expert validator, among others, from the learning expert was 3.82. For material experts, it gave a score of less than three, namely 2.82 with several notes to be revised, while for media experts it was 3.7, was presented in Figure 2.

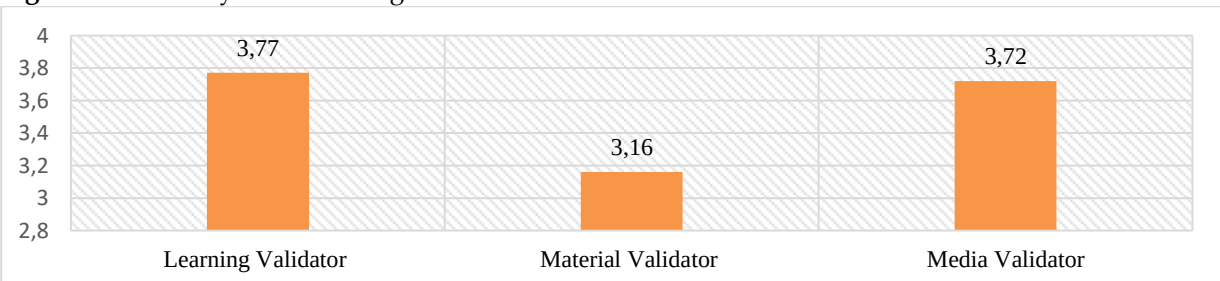
Figure 2. Feasibility Test RPP



The average score of the three experts is 3.44 with the conclusion that this score is in the feasible category. Thus, based on the above feasibility test, the results of one product from the learning device, namely in the form of a learning implementation plan (RPP), are suitable for use in learning.

Figure 3 the results of the feasibility assessment of the teaching material above showed that the learning experts gave a score of 3.77 for the material experts 3.16 and 3.72 for the media experts.

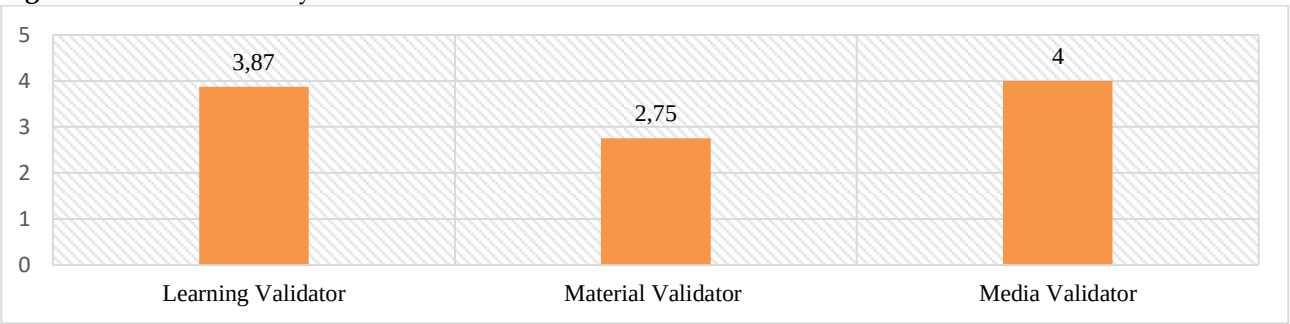
Figure 3. Feasibility Test Teaching Material



The average assessment of the three experts is 3.83 with the conclusion that this value falls into the very feasible category, thus based on the feasibility test above, that the results of one product from the learning device, namely in the form of teaching material, are suitable for use in learning.

Figure 4 the results of the LKPD feasibility assessment by expert validators included, among others, the learning expert gave a score of 3.87, the material expert gave a score of 2.75, and the media expert gave a score of 4.00.

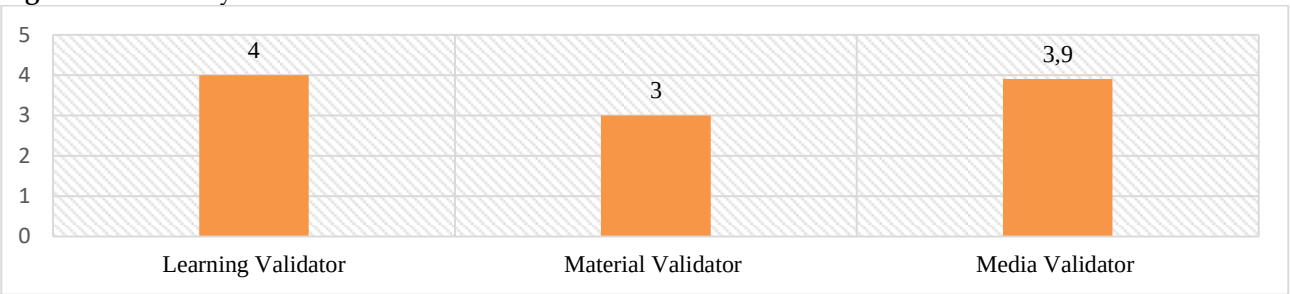
Figure 4. LKPD Feasibility Test



The average rating of the three experts is 3.54 with the conclusion that this score falls into the very feasible category. Thus, based on the above feasibility test, the results of one product from the learning device, namely in the form of student worksheets (LKPD), are suitable for use in learning.

Figure 5 the results of the assessment of the feasibility of teaching materials by expert validators included learning experts giving a score of 4.00, material experts giving a score of 3.00, and media experts giving a score of 3.9.

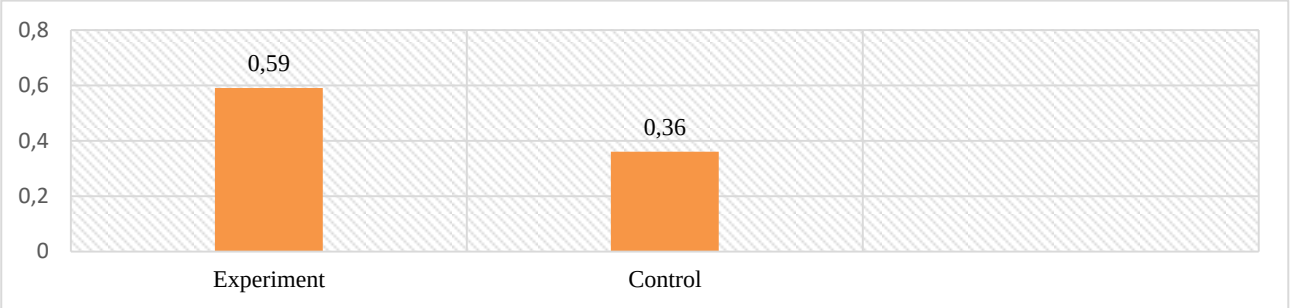
Figure 5. Feasibility Test for Valuation Instruments



The average rating of the three experts is 3.63 with the conclusion that this score falls into the very feasible category. Thus, based on the above feasibility test, the results of one product from the learning device, namely in the form of an assessment instrument, are suitable for use in learning.

Figure 6 the average N-gain value of students' creativity between the experimental class and the control class.

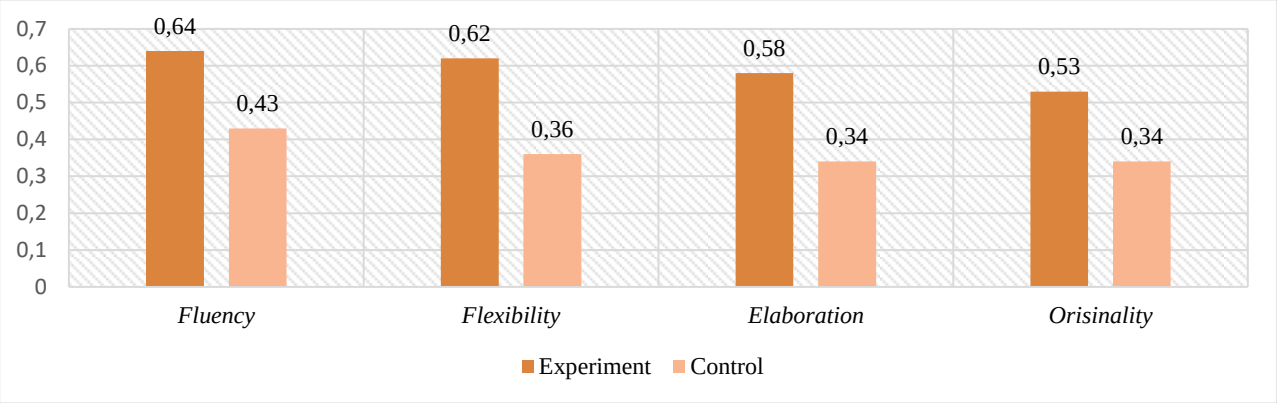
Figure 6. Differences in the Average N-Gain Value of Students' Creativity



The average N-gain value in the experimental class of 0.59 is included in the medium category, while the average N-gain value for the control class is 0.36 which is in the low category.

Figure 7 the graph of the average n-gain for each indicator of the creativity of the experimental and control class students.

Figure 7. Average N-Gain Value in Each Aspect of Creativity



Based on this figure, it can be seen that the experimental class n-gain average is greater than the control class n-gain average. The n-gain average of the experimental class in each aspect shows a large difference.

RESULT, DISCUSSION, AND SUGGESTIONS

The defining stage seen from the results of observations and interviews shows that the teacher still uses the lecture and discussion method in learning. So that students tend to be passive in learning activities. The school already has a laboratory but the materials are limited, so the application of learning is replaced with video. The teacher rarely invites practicum and experiments with the surrounding environment because it takes a long time to implement it. The approach that is often used in learning is the scientific and contextual approach. The STEM approach is rarely used because teachers have difficulty using it in learning. The difficulty of using STEM in learning is because students do not understand the condition of the surrounding environment and relate it to learning.

Teachers still have difficulty in preparing learning tools, so that the preparation of devices is still guided by teacher books and student books. According to the results of the teacher interviews, it was difficult to prepare LKPD and assessment instruments. So that in teaching teachers always use the learning tools that have been provided. The teaching materials used by the teacher are actually good, but the teacher still has difficulty in sorting the sub-chapters studied so that they are not coherent. Before learning begins, teachers also rarely give apperception, that is, if the PjBL-STEM syntax is called reflection, usually the teacher tends to start learning right away. Teachers in this case also still have difficulty using LKPD because they rarely use them in learning, so that students are still not used to using LKPD in learning to find concepts independently by linking them in everyday life. The final problem that was found regarding learning devices was the assessment instrument used by the teacher. The teacher still uses the test form assessment instrument. This is of course not able to know the overall picture of students' learning abilities and completeness.

The results of the analysis of the learning device documents showed that the syllabus used was not in accordance with Permendikbud No. 22 of 2016. The syllabus used by science teachers at one of the SMP Negeri Surakarta area did not match the format. The syllabus also does not lead to 21st century skills. The lesson plans used are also not in accordance with basic competencies. This can be seen from the indicators in the lesson plan that do not match the basic competencies achieved. In addition, the models and methods used by teachers are still monotonous. Teachers still often use the lecture method in learning so that students tend to be passive and learn because they still apply the teacher center.

The results of the initial test analysis of the percentage of students' creativity ability were low. The initial analysis was carried out in order to determine the creativity ability of students in analyzing and answering questions. The low factor of creativity is due to one of them, namely the use of real problem solving around students that does not exist. Creativity is an activity that requires new ideas skills. This initial

profile was observed in two classes in one SMP Negeri Surakarta city, with 52 subjects consisting of 28 boys and 24 girls. Data were collected using test instruments to analyze students' answers to the average results obtained and the achievement of indicators based on the aspects of creativity, namely fluency (26.25%), flexibility (28.75%), elaboration (38.75%), and originality (28.75%) with low criteria. The results of the analysis of the initial profile of students' creativity were carried out to determine the initial description of the characteristics of students based on their background and cognitive abilities.

This initial design was carried out by compiling an initial draft related to the development of learning tools consisting of a syllabus, lesson plans, teaching materials, LKPD, and assessment instruments. At the design stage, the first draft or draft 1 will be produced which will then be validated at the development stage. Before designing the steps taken, namely designing the learning content and selecting appropriate learning resources. Media selection is also carried out in the initial design. The selection of center media is chosen to make it easier for students to use teaching materials when learning activities take place in class or outside the classroom. The learning tools developed as a whole in this study will also be recorded. In addition to print media, audio-visual media such as video (Youtube) are also used to make it easier for students to understand learning. This media is usually used in the reflection phase in the first step of STEM-PjBL learning.

The syllabus is prepared according to the steps of the PjBL model with a STEM approach. The syllabus developed emphasizes aspects of the PjBL-STEM model which aims to improve students' mastery of concepts. Catch-up syllabus with an allocation of 15 lesson hours (15JP). RPP is developed referring to the syllabus that has been prepared. The preparation of the RPP is also based on Permendikbud of the Republic of Indonesia Number 65 of 2013 concerning process standards. The lesson plans compiled consist of several parts, namely the identity of the lesson plans, core competencies, description of core competencies, basic competencies, indicators of competency achievement, learning objectives, approaches, methods, learning models and media, tools, and learning resources.

Teaching materials are a systematically arranged material set that teachers use to assist in carrying out the learning process. This teaching material consists of several parts, namely covers, French sheets, foreword, table of contents, instructions for use, KI and KD, concept maps, problems around us, STEM integrated PjBL model LKPD, material in-depth assignments, self-assessments and summaries. , as well as a bibliography. LKPD is compiled into several interesting titles related to problems surrounding daily life. The part of the LKPD that is being developed includes the surrounding problems in the form of an online newspaper regarding environmental pollution, group identity, the title of the problem, the LKPD instructions, and steps to make a discovery (research). The design stage produces a product consisting of a syllabus, lesson plans, teaching materials, LKPD, and assessment instruments. This product is specifically named as draft 1. Draft 1 then enters the development stage to be later validated so that its feasibility value is known for use.

The average N-gain value of students' creativity between the experimental class and the control class. The average N-gain value in the experimental class of 0.59 is included in the medium category, while the average N-gain value for the control class is 0.36 which is in the low category. Based on these data, it can be said that the N-gain average value of the experimental class is greater than the N-gain average value of the control class. Based on the above results it can be concluded that the research on the development of science learning tools is considered effective in increasing the creativity of students and the N-Gain value of the experimental class is greater than the control class. The factor that supports the increased N-gain value is the application of the PjBL-STEM model in learning.

The graph of the average n-gain for each indicator of the creativity of the experimental and control class students. Based on this figure, it can be seen that the experimental class n-gain average is greater than the control class n-gain average. The n-gain average of the experimental class in each aspect shows a large difference. The fluency indicator in the experimental class has the highest value, namely 0.64 in the medium category. The lowest n-gain value is shown in the originality aspect with a value of 0.53 and is included in the medium category. Meanwhile, the n-gain average value of the control class shows that the fluency aspect

has the highest value, namely 0.43 and is included in the moderate category. The smallest n-gain value is shown on the elaboration and originality indicators and is included in the low category.

The entire series of feasibility and validity tests by experts, students, and teachers has proven that the product developed, which is a science learning tool, is suitable for use in learning. Research conducted by Pangesti, et al (2017) states that developing STEM-based teaching materials can improve students' mastery of concepts. This can be seen from the average pretest score of 38.19, increasing the post-test score to 81.99 with a completeness percentage of 82.76%. From the results of the pretest and posttest were also analyzed using the gain value test, it was obtained that 0.71 showed that the learning applied in the class had high effectiveness in improving students' mastery of concepts.

The data on the creativity value of students was carried out by the prerequisite test, namely the normality test and the homogeneity test as a prerequisite for the parametric hypothesis test. The normality test in this study used the Kolmogorov Smirnov equation, while for the homogeneity test used the Levene Statistic equation. If the data was normally distributed and came from variants After that, a hypothesis test can be done, namely the Independent Sample t-Test to see if there is a difference in the students' concept mastery ability. The tool used to perform this uni is the SPSS 23 for Windows 10 software.

The results of the normality test show that the creativity value of the experimental class (0.200> 0.05) and the control class (0.117> 0.05) can be seen from the significance value greater than 0.05 with Ho's decision accepted so that it can be concluded that the data is normally distributed . The requirement that must be met for parametric hypothesis testing is homogeneity. The results of the homogeneity test showed a significance of more than 0.05 (0.314> 0.05) so that it could be concluded that Ho was accepted and H1 was rejected, with the conclusion that the data tested met the homogeneous requirements. If the prerequisite test is normally distributed and homogeneous, it means that the right-hand t-test can be done. The reason for this test is the researchers' assumption that the creativity of students using the PjBL model of science learning tools with the STEM approach is better than students who use conventional learning tools.

The results of the hypothesis test can be seen from the t value which is greater than t table (1.724 <5.813) indicating that there is a difference in creativity between the experimental class using the PjBL model of science learning tools with the STEM approach and the class without using the device, so Ho's decision is rejected by draw the conclusion that the experimental class is better than the control class. This value is the value of the 5% (0.05) significance level. Ho is rejected so that H1 is accepted, it can be said that the creativity of students who are taught using the PjBL model of science learning tools with the STEM approach with class without using these devices. These results are also supported by the mean difference between the experimental class and the control class.

Project-based learning models can provide opportunities for students to develop their creativity. Research conducted by Kusumaningrum & Djukri (2016) states that the development of the PjBL (*Project Based Learning*) model is more effective in increasing the creativity of students. Research conducted by Ismayani (2016) states that STEM-PjBL can improve students' creative thinking skills. Research conducted by Liska Nurfitriagina (2017), shows that the implementation of STEM-based learning through the PjBL model obtained an average value of 78.17%. The research that has been conducted has limitations in the process or stages, some students are still not used to using the PjBL-STEM model.

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