The analysis of project based learning implementation to improve students creative thinking skill in solving the problem of tiles coloring combination

S Waliyati¹², Dafik¹², Slamin¹³
¹CEREBEL University of Jember, Indonesia
²Mathematics Edu. Depart. University of Jember, Indonesia
³Departement of Informatic, University of Jember, Indonesia

Email: selvibkk29@gmail.com

Abstract. This research aimed at analyzing the implementation of project based learning to improve students’ creative thinking skill in solving the problem of tiles coloring combination pattern. The methods used in this research were in the form of combined methods that were qualitative and quantitative. The subject of this research consisted of 42 students in the control group and 44 students in the experimental group. The pre-test data of the control and experimental classes were tested by using independent sample t-test which showed sig (2-tailed) 0.726 (p > 0.05), therefore there was no significant different between the result of students’ achievement of the control and experimental classes. This stated that the result of the second class pre-test was homogenous. In the other hand, the post-test data of the control and experimental classes were analyzed by using independent sample t-test and the result of Sig. (2-tailed) 0.00 (p < 0.05), it could be concluded that there was a significant different after the implementation of project based learning.

1. Introduction
Nowadays, education influences the generation of the nation. All education fields are always improved, developed, and upgraded. The improvement in education field covers some various components which involve the implementation, education quality, curriculum instrument, and education facilities as well as the improvement of teaching strategy and method [2].

There were some methods used to improve the students’ achievement in learning process. One of the efforts done in this research was the implementation of project based learning method. The procedures of project based learning developed by [6] consisted of:

Start With The Essential Question
Assess The Outcome
Evaluate The Experience

Design A Plan For Project
Monitor The Student And The Progress Of The Project
Create A Schedule

Figure 1. The Procedures of Project Based Learning Model
Project based learning is a learning method which has been implemented in developed country like United States [12]. Project based learning is a learning which is based on a project. In this research project based learning was implemented to college students in solving the problem of tiles coloring combination pattern in number pattern material. The activity of the teacher and the students in PJBL approach consisted of three steps that were preparation, learning, and evaluation in which from those three steps it could be described into six steps [5]. First, the students determined the basic question about tiles coloring pattern which was an open ended one. Second, the students arranged the project plan and prepared the tools. The plan consisted of the rule of the project making. Third, the students arranged the schedule to finish the project, and then they divided the project task in group and planned a new coloring pattern. Fourth, the teacher monitored the students’ progress of the project while finishing the project. Fifth, assessed the product by asking each student to explain their finding result about coloring pattern, nth formula and function formula. Sixth, the teacher evaluated the project produced by students and the students proved the project.

An empirical evidence shows that experiential education addresses specific methods and Project-Based Learning [2]. The core idea of Project Based Learning is that problems in the real world attract interest and provoke serious thinking when students acquire and apply new knowledge in the context of problem solving. Project-based learning models can occur inside or outside the classroom.

In learning process, the students were required to think and solving problem. There are some thinking levels in learning in which, according to high-level thinking can be categorized as follows: (1) retention thinking level, (2) basic thinking, (3) critical thinking, and (4) creative thinking [4].

Based on the opinion above, this research required students to think creatively. The creative thinking levels, according to are divided into four levels: level 4 (very creative) fulfilled the aspect of fluency, flexibility, and novelty, level 3 (creative) covers the aspect of fluency and flexibility, level 2 (fairly creative) covers the aspect of novelty or flexibility, level 1 (less creative) covers the aspect of fluency in solving problem, and level 0 (not creative) the students are not able to show the three indicator aspects of creative thinking [9].

The analysis explained above represented how project based learning approach could facilitate the students creative thinking process. The relationship between the indicators of creative thinking and the project based learning steps was shown as follows:

| Code – Creative thinking | Code – Project based learning |
|--------------------------|-----------------------------|
| K1 Fluency               | P1 Asking                   |
|                         | P2 Project planning         |
| K2 Flexibility          | P3 Project arranging        |
|                         | P4 Monitoring               |
| K3 Novelty              | P5 Testing                  |
|                         | P6 Evaluating               |

His research aimed at analyzing the implementation of project based learning to improve creative thinking skill [10]. This research used a number pattern applied as a coloring pattern on tiles in identifying the students’ creative thinking skill. There were several number patterns that could be seen, as follows: odd number pattern, even number pattern, triangle number pattern, square number pattern, rectangle number pattern, partial triangles and Fibonacci number pattern[8]. There were two colors with a square pattern of tile coloring pattern used in this research. While, for the use of number pattern variations, odd number pattern was mostly used in this research.
The teaching material that will be used in this research is generalization of tile coloring patterns with nxn size images. The coloring pattern produced by students will be generalized into a more complex form, so that the design results obtained can be used in everyday life and can be recommended as an installation that is approved to be applied to customer orders. The number pattern in the coloring pattern forms an arithmetic. The number of colors needed only contains two color elements, for example red and white will produce a formula of the number of the automatic arrays found in the coloring pattern. The number pattern must be extended to n according to the initial pattern, and a formula can be found to change the function of the color variation symbolized \( f(x_{ij}) \) so that any result can be known.

2. Methods

This research used the mixed method that is the combination of qualitative and quantitative methods[11]. Qualitative method used observation and interview data while quantitative method used pre-test and post-test data. Quantitative method was done by involving two classes that were experimental and control classes. Then, each class was given a test before and after the teaching and learning process by considering the indicators of creative thinking skill.

| Experimental Class | O₁ | X₁ | O₃ |
|--------------------|----|----|----|
| Control Class      | O₂ | X₂ | O₄ |

Descriptions

- \( X_1 \): Learning process by using Project Based Learning method
- \( X_2 \): Conventional learning
- \( O_1 \) & \( O_2 \): Pre-test
- \( O_3 \) & \( O_4 \): Post-test

In this design, there were two groups that were selected randomly (R). The first group was given a treatment by using Project Based Learning method called an experimental class and the group that was not given a treatment called control class. Both classes showed the results of effectiveness after solving the problem given [10].

The creativity of students who are different from each other requires learning, so that creative potential can be developed. All students with different academic abilities can develop their thinking skills, if the learning environment provides opportunities to develop creative thinking skills [3]. One effort to develop creative thinking skills is to create environmental learning primarily by involving students' real experiences in learning [13]. Selecting the appropriate learning model will be planned to improve their academic abilities. The efforts made by researchers using a project-based learning model. the applied learning model can improve the ability to think creatively so that an effective learning model can involve between students with high academic abilities and students who have low academic abilities.
The analysis of student creative thinking skill solving under the implementation of project based learning on research

**Figure 2.** Triangulation model of triangulation method
2.1. Population
The population of this research was all the students of mathematics education, University of Jember. The samples were taken randomly that were two classes suggested by the lecturer of this subject. The results were 42 students for the control class and 44 students for the experimental class.

2.2. Instrument
The instruments in this research were in the form of tests (pre-test and post-test), observation and interview. The observation used a scale of 0-4 in which level 4 means very creative, level 3 means fairly creative, level 2 means fairly creative, level 1 means less creative, and 0 means not creative. The test, observation, and interview were validated by the mathematics education experts [9].

2.3. Task
In this research, the researcher gave a task to the subjects which belonged to the experimental and control classes. The instrument that fitted the indicators was given to the students to measure the students’ ability [7]. A test was given to the experimental and control classes in the form of pre-test and post-test sheets containing several columns to find out different tile patterns, the number of color pattern, and the n-th formula. The following was the table to find the number of tiles color, take a look at this following figure 3.

\[
\begin{align*}
    n = 1 & \quad (1,0) \\
    n = 2 & \quad (4,0) \\
    n = 3 & \quad (8,1) \\
    n = 4 & \quad (12,4) \\
    n = 5 & \quad (19,6) \\
    n = 6 & \quad (24,12)
\end{align*}
\]

**Figure 3.** Example of the tiles pattern coloring of U₁ – Uₙ

After knowing the number of red and white tiles, to find out the n-th formula by using the tiles number of each tribe with arithmetic number pattern formula number 1 and 2 like \( U_n = a + (n - 1)b \).

2.4. Data Collection and Analysis
The pre-test and post-test data were taken from the studied experimental and control classes. The implementation of quantitative data analysis used t-test, while the qualitative data used interview, observation, and data analysis by using ordinal data.

Descriptive and inferential statistics were used to analyze qualitative and quantitative data. The used statistics data was obtained from the mean value, standard deviation, and frequency. In addition, normality, homogeneity, and independent tests between the experimental and control classes were used in inferential data related to the Project Based Learning. Linear regression test analysis was used to the experimental class that was given a treatment. The independent sample was used to compare the two classes with the different significance value of 0.05 level.
3. Research Findings
We need to test the reliability and validity of our research instruments from the three validators before showing the results of our research. The following table shows the reliability and validity of the results.

| Correlations | No_1 | No_2 | No_3 | No_4 | Total_ |
|--------------|------|------|------|------|--------|
| No_1         |      |      |      |      |        |
| Pearson corelation | 1    | .565** | .745** | .177 | .436** |
| Sig (2-tailed)   | .000 | .000 | .250 | .000 |        |
| N             | 44   | 44   | 44   | 44   | 44     |
| No_2         |      |      |      |      |        |
| Pearson corelation | .565** | 1    | .683** | .012 | .421** |
| Sig (2-tailed)   | .000 | .000 | .936 | .004 |        |
| N             | 44   | 44   | 44   | 44   | 44     |
| No_3         |      |      |      |      |        |
| Pearson corelation | .745** | .683** | 1    | .028 | .555** |
| Sig (2-tailed)   | .925 | .471 | .773 | .000 |        |
| N             | 44   | 44   | 44   | 44   | 44     |
| No_4         |      |      |      |      |        |
| Pearson corelation | .177 | .012 | .028 | 1    | .469** |
| Sig (2-tailed)   | .250 | .936 | .859 | .001 |        |
| N             | 44   | 44   | 44   | 44   | 44     |
| Total        |      |      |      |      |        |
| Pearson corelation | .635** | .421** | .555** | .469** | 1      |
| Sig (2-tailed)   | .000 | .004 | .000 | .001 |        |
| N             | 44   | 44   | 44   | 44   | 44     |

**. Correlation is significant at the 0.01 level (2-tailed).

The data are said to be valid if the sig (2-tailed) data is <0.05. It can be seen that the value of all questions above number 1, number 2, number 3, number 4 are all valid.

| Table 4. The test result of the realibility question |
| Reliability Statistics |
| Cronbach's Alpha | N of items |
| .688            | 4           |

Based on table 4, it can be see that the overall reliability value is 0.688 and \( r_{table} \) of a significance level of 5% with \( dk = N−2 = 42 \), the decision that Alpha > \( r_{table} \) that is 0.688 > 0.2512 it can be concluded that instruments items are reliable.

Based on the results of the pre-test analysis between the two, it can be seen that the two classes have the same variance. The results showed that the pre-test of creative thinking skills in the experimental class was 21% having very creative, The percentage of pre-test results on creative thinking skills in both experimental classes could be seen in the following diagram.
Figure 4. The distribution of pre-test of student creative thinking skill in the experiment class.

The results of the pre-test show that there are five categories of creative thinking, one that is very creative category of 14%, while those who are not creative are only 5%. The results of the pre-test in control class can be seen in diagram below:

Analysis of research results, findings related to the effectiveness of PJBL based learning on the basis of independent sample t-test using t-test analysis obtained from the value of the pre-test and post-test. The total respondents of classes consisting was 86 subjects. This avanced that pre-test result of both classes was significantly different, as seen in table below.
Table 5. The results of normality test on pre-test in the control and experimental classes

| Group | N  | Mean | Std. Deviation | Kolmogorov-Smirnov Z | Sig. (2-tailed) |
|-------|----|------|----------------|----------------------|----------------|
| The pre-test score of experiment class | 44 | 18.11 | 2.498 | .134 | .046 |
| The pre-test score of control class | 42 | 17.71 | 3.078 | .139 | .039 |

The distribution of the table above showed that the results of the pre-test in the control and experiment classes were normal with 0.05 of significant level whereas Sig. (2 tailed) of control class was 0.039 and experimental class 0.046. Thus, the pre-test scores were able to be distributed normally as 0.039 and 0.046 > 0.05. The mean score obtained in the control class was 17.71 and 18.11 in the experimental class. Meanwhile, Standard deviation got in control class was 3.078 and 2.498 in experimental class.

Table 6. The results of homogeneity test on pre-test results in the control and experimental classes

| Test of homogeneity of variance | Levene statistic | Df1 | Df2 | Sig. |
|--------------------------------|-----------------|-----|-----|------|
| Score                          | 1.875           | 1   | 84  | .175 |

The results of homogeneity test above obtained the value of Sig, 0.175 > 0.05, so that the pre-test scores of control and experimental classes were homogeneous.

Table 7. The Results of independent test on pre-test in the control and experimental classes

| Independent Sampel Test | Levene’s Test for Equality of Variances | t-test for Equality of Means |
|-------------------------|----------------------------------------|-------------------------------|
|                         | Of Variances                           |                               |
|                         | F  | Sig. | t  | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
|                         |    |      |   |    |               |                 |                         | Lower | Upper |
| Pre-test Equal variances assumed | 1.87 | .175 | - | 84 | .510 | -.399 | -.603 | -1.599 | .800 |
| Pre-test Equal variances not assumed | 78.991 | .512 | -.399 | -.606 | -1.606 | .807 |

In relation to the results of independent test above, it was found that Sig. (2-tailed) was 0.510, 0.512 > 0.05 under a condition if Sig (2-tailed) > 0.05, then there was no significant difference.
between the learning outcomes of the control and the experimental classes. So, the results of pre-test between the control and the experimental classes had no differences.

Post-test analysis of the ability to think creatively in the experimental class and the control class can be seen in the diagram below. The highest percentage of post-test experiment class is 41% of students who reach very creative levels, meaning that in the experiment class when doing the post-test there was increase. The results of the distribution and percentage of the post-test experiment class can be observed in bellow.

Figure 6. The distribution of post-test of student creative thanking skill in the experiment class

The result showed post-test creative thinking skill in control class was 27% had very creative, 27% were in creative category ability, and 25% were in fairly creative ability, and the rest 19% in the less creative and not creative thinking 2%.The results of the control class post-test showed a slight increaseand percentage post-test in control lass can be seen in figure below:

Figure 7. The distribution of post-test of student creative thanking skill in the control class.
The results of the study after the pre-test, findings related to the effectiveness of project based learning on the basis of independent sample t-test using t-test analysis were obtained from the post-test values. This allows the post-test results of the two classes to be very different, as shown in the table below.

Table 8. The Results of normality test on post-test in the control and experimental classes

| Group                               | N   | Mean | Std. Deviation | Kolmogorov-Smirnov Z | Sig. (2-tailed) |
|-------------------------------------|-----|------|----------------|----------------------|-----------------|
| The post-test score of experiment   | 44  | 27.91| 2.701          | .122                 | .102            |
| class                               |     |      |                |                      |                 |
| The post-test score of control class| 42  | 21.38| 2.399          | .104                 | .200            |

It could be seen on the table that the results of normality test on post-test done in control class and the experimental class were normally distributed since the value of Sig. > 0.05 which was 0.102 and 0.200 > 0.05.

Table 9. The results of the homogeneity test of the post-test results in the control class and experimental class

| Test of homogeneity of variance | Levene statistic | Df1 | Df2 | Sig. |
|---------------------------------|------------------|-----|-----|------|
| Score based on mean             | 1.436            | 1   | 84  | .234 |

The post-test analysis of homogeneity test in the control and experimental classes was proved to have homogeneous distribution with Sig. 0.234 > 0.05.

Table 10. The results of Independent test on post-test in the control class and experimental classes

| Levene's Test for Equality of Variances | t-test for Equality of Means |
|----------------------------------------|-----------------------------|
| F                                      | Sig. | t       | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference |
|                                        |      |         |    |                |               |                    | Lower           | Upper           |
| Pre-test                               | 1.43 | .234    | 6  | .000           | -6.528         | .552               | -7.625          | -5.431          |
| Equal variances assumed                |      |         |    |                | -11.831        |                     |                 |                 |
| Equal variances not assumed            |      |         |    |                | 83.576         | .000               | -7.622          | -5.434          |
|                                        |      |         |    |                | 11.864         |                     |                 |                 |

The data above shows that the results of Sig. (2-tailed) is 0.00 (p = <0.05) so this proves that control and experiment classess grade represents a difference in terms of student achievement after implementation of PJBL.
Based on the results of the independent test above it can be concluded that there is a significant effect of the implementation of project-based learning on student performance in solving the problem of tiling pattern tiles.

According [10] to these results we can conclude that the results of the post-test on the experimental class and the control class have increased at a very creative level towards student achievement in solving the tile pattern coloring problem.

To ensure our results, we share observations with all subjects in the experimental class, items carried out by 10 observers, and use a Likert scale that includes very active (score 5), active (score 4), doubtful (score 3), inactive (score 2), very inactive (score 1). The results of observations can be shown in the following chart.[7]

![Percentage of Activity Criteria](image)

Based on Figure 8, the students involved in the observation were 38 students. It was found that during the PJBL implementation, students who were very actively involved in a tile pattern staining solution got the highest score from the research subjects with observational criteria reaching 46%, being cative and hesitate reaching 20% doubtful, 9% for students inactive and the last 5% for students who meet the criteria are very inactive. It can be concluded that PJBL can work well in the learning process in solving color tile patterns.

The results of student test observations show that students are able to conceptualize tile staining patterns. They can use their ability to create new patterns that are different from others. Below are the results of students work in completing the pre-test and post-test. The following is a project produced by the experimental class students when working on the post-test using the PBL model. The results obtained by students can be analyzed from low, medium, and high criteria.

According [7], the higher the level of thinking, the more students are able to show many possible answers to a problem. All answers produced must be correct and must vary. The following are the results of varying student thinking and that show some answers to post-test questions in the experimental class.
Figure 9. Subjek 1 criteria is low

First subject, gets a low criterion because the first subject can only determine the coloring pattern and the number of each pattern.

Figure 10. Subjek 2 criteria is medium

In the results of subject 2 slightly different from the subject 1, subject 2 can find the pattern of paving staining differently from the coloring pattern on subject 1. Besides finding a different pattern, subject 2 also finds the nth formula, but subject 2 cannot determine the function formula on the pattern. After the researchers analyzed the learning outcomes in subject 2, the criteria were medium.
Project results on subject 3, get high criteria because subject 3 produces a different pattern, calculates the number of pattern numbers, finds the nth formula, the formula for laying the color function.

After observing some of the results above, the researcher conducted an interview to the research subjects who got the criteria of low, medium and high. Interviews conducted aim to find out the flow of students' thinking in completing the project. Following excerpts of interviews with the subject as follows:

Researcher: what do you get after reading work sheets?
Student: I get a description of tiny pattern patterns.
Researcher: what information do you need after answering the question?
Student: I found, that I had to complete dye patterns like examples, make new coloring patterns.
Researcher: how are you doing a second command?
Student: I have to complete a form to look for a lot of dyes, complete cardinality and formulating functions.
Researcher: when you are connecting to the pre-test, how you have to solve it.
Student: basically, it's only simple with the pre-test. But I understand the difficulties because I don't understand about determining formulars. So I can find some new patterns.
Researcher: in post-test, what difficulty are you natural?
Student: I feel difficulty when looking for dyeing patterns that are not compatible with the number of patterns.
Researcher: next you have a special pattern of coloring tin patterns, can you announce reports and write it expressly?
Student: the pattern I obtained in the form of tin patterns with red and white colors. The search processing principal pattern began from u1 to un. As well as I found it forum.

In the project completion path, students worked on different patterns that were sequential and jump. The phase portrait chart can be seen as follows:
4. Discussion
This research was conducted to analyze the ability of creative thinking skill in the implementation of project based learning. Creative thinking skill fulfilled a number of indicators, namely fluent thinking, flexible thinking, original thinking, and detail thinking. The subjects used were 42 students in control class and 44 students in experimental class. The implementation of project based learning was done in experimental class. It had been known that, from the result of data analysis, in the experimental class there was an effect in conducting project based learning method on creative thinking skill.

The results of the independent test sample t-test on the pre-test questions on the control class and experimental class obtained the Sig. (2-tailed) is 0.039 and 0.046 > 0.05 in conditions if Sig (2-
tailed) > 0.05, then there is no significant difference between the results of learning control and the experimental class. Whereas in the post-test results, independent tests were obtained in the experimental class control class with Sig. (2-tailed) is 0.00 (p = < 0.05) so that it gets a significant value. This proves that the two classes represent differences in terms of student achievement tests after the PJBL implementation.

The purpose of [1] research on the application of writing learning uses project based learning models in Arabic language learning for seventh graders of Madrasah Tsanawiyah Nurul Huda Malang and gets the results of increasing the ability to write Arabic by applying project based learning models to class VII Madrasah Tsanawiyah Nurul Huda Malang. As for this research, it can be concluded that the application of Arabic learning with a project based learning model can improve the writing skills of Grade VII students of Madrasah Tsanawiyah Nurul Huda Malang.

This study uses the project based learning model to improve students' creative thinking skills so that the project is based on learning models in this study influences students' processes in learning. As for this research in the research with [5] the results of the implementation of project based learning were able to improve student discipline in conducting learning, so that the model based learning discipline in learning influences model.

Based on data obtained through interview results, each student can provide a positive response through their comments regarding the implementation of project-based learning. Before using project-based learning, students have difficulty finding ideas and difficulties in class lectures. After doing project-based learning, students get active criteria in finding tile coloring patterns.

5. Conclusion

Based on the research that has been done it shows that the application of PJBL has a significant effect on creative thinking skills of students in the experimental class. Students in the experimental class showed their creative thinking skills compared to the control class. The results showed that the improvement in student learning outcomes and creative thinking skills was seen from the post-test. The value of the experimental class is better because it is supported by project-based learning (PJBL) in learning to improve students' creative thinking.

Acknowledgement

We would like to express our gratitude for the tremendous support from the education teachers of university of Jember, especially the lecturers of the mathematics education program and members of CGANT, CEREBEL, and the research group.

References

[1] AA Syamfa, 2017 Application of the project based learning model to improve students' writing skills journal of arabic studie, 2 (2) 186-196
[2] Aspaite-Roehamton University, I A 2014 Experimental Education Through Project Based Learning Procedia Social And Behavioral Sciences, 1256-1260.
[3] E Gregory, M. H2013 Building Creative Thinking In Classroom: From Research To Practice.International Journal Of Educational Research, 43-50.
[4] K K Khuan T T S 2017 An instructonal design model with the cultivating research based learning strategies for fostering teacher student’ creative thinking abilities. Educational research and reviews 12 (15) 712-724
[5] O Kizkapan, O. B. 2017 The Effect Of Project Based Learning On Seventh Grade Students' Academic Achievement. International Journal Of Instruction, 37-54.
[6] S K Wah Chu, Y. Z2017The Effectiveness Of Sikis For Project Based Learning In Different Disciplines In Higher Education International Journal Of Educational Research, 29-60.
[7] Suntusia, Dafik, Hobri, 2018. The Effectiveness Of Research Based Learning In Improving Students’ Achievement In Solving Two-Dimensional Arithmetic Sequence Problem. international journal of instruction, 12(1). In press.
[8] Sutarto. Nusantara, T. Subanji. hastuti, I. Dafik. 2016. Global Conjecturing Process In Pattern Generalization Problem. J. phys.: Conf. Ser. 1008012060.
[9] T Y E Siswono. 2010 Leveling Students’ Creative Thinking In Solving And Posing Mathematical Problem. IndoMS. J.M.E 17-40.
[10] Tahir, M. Abidin, Z. Dafik. 2018. Students Creative Thinking Skill In Solving Two Dimensional Arithmetic Series Through Research Based Learning., journal of physics: conf.series 1008 (2018) 012072
[11] U Inuwa, Z. A. (2018). A Mixed-Method Study Of The Effect Of The Demonstration Method On Students' Achievement In Financial Accounting. International Kournal Of Instruction, 577-592.
[12] VBG omez, Pablos M M d Pozo, A G Valcarcel M Repiso 2017 Project-based learning (PBL) through the incorporation of digital technologies: An evaluation based on the experience of serving teachers Computers in Human Behavior68 501-512
[13] Yusnaeni, A. D. (245-262). Creative Thinking Of Low Academic Student Undergoing Search Solve Create And Share Learning Integrated With Metacognitiv Strategy. International Journal Of Instruction, 2017.