



Transformation Geometry Learning by Crossword Puzzle Model

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ABSTRACT

*This research objective is to describe the effectiveness learning by crossword puzzle model and students' learning achievement. The research method used experimental research, by One-Shot Case Study design, in which there was a group given a treatment, then its result/achievement in Transformation Geometry and students' response about that model was analysed. This research was conducted in the University of Balikpapan. The subject of this research was the 5th semester students of Mathematics Programme (Class A & B). With questionnaire analysis, the effectiveness learning by crossword puzzle model is **75,29%**, and mean of students' learning achievement are **87,18** (Very Good) and **72,88** (Good). Hence, learning by crossword puzzle model can give a good learning achievement for students of Mathematics Programme in University of Balikpapan.*

INTRODUCTION

One of the most important areas of science in education is mathematics. Mathematics is a universal science that underlies the development of modern technology, it plays an important role in various disciplines, and develops the power of human mind (Masykur & Fathani, 2007: 52; In'am, 2012: 10). The magnitude of the role makes mathematics a compulsory subject in school, and the need for a strong mastery of concepts from an early age. Even if a country neglects mathematics education as a top priority, it will be left behind from other countries that provide a place for mathematics as a very important subject (Masykur & Fathani, 2007: 41).

Organizing good and quality mathematics learning in school is a must that is not negotiable (Masykur & Fathani, 2007: 56). It was not his time that mathematics was regarded as a fear factor, lofty lesson, dry-abstract science, only theoretical, full of difficult formulas and questions, and other negative assumptions of students (Manfaat, 2010: 59; Masykur & Fathani, 2007: 56). So mathematics is no longer a fun subject for students, and even shunned by them.

Because these problems, teacher has a very important role in the process of learning mathematics in schools. The success of learning mathematics is supported by teacher skill in carrying out teaching activity and awareness of students in following learning activity (In'am, 2012: 17). Therefore, in the learning required the ability of teachers in managing learning and or ability in managing the class. Teachers must have qualified abilities in the areas of strategy and varied learning model. Learning model used by teacher should be appropriate and in accordance with the condition of students in terms

of age, time, and other variables. For that, it needs to be held active and fun learning so that students can express themselves in learning and not experience saturation, so that students can understand the lessons well (Wijiastuti, 2013: 31). In learning activities, one way that can be held by teachers to solve the problem is to provide a learning model that is able to optimize the role of students in learning, that is with Puzzle.

Bowers (in Babayemi & Akinsola, 2014: 8) identifies several types of puzzles, including: Wooden Puzzles, Jigsaw Puzzles, Crossword Puzzles, Logic Puzzles (Word Puzzles or Mechanical Puzzles), Pattern Puzzles (colors, shapes, or combination of word), Riddles and Brain Teasers, and Mazes and Picture puzzles. Among all these types of puzzles, researcher use the Crossword Puzzle.

Crossword Puzzle is a game where we have to fill the empty spaces (white box shapes) with letters that form a word based on the instructions given. The instructions are usually divided into "horizontal" and "vertical" categories depending on the position of the words to be filled (Nafi & Sulisty, 2014: 39; Ali & Endryansyah, 2015: 368). In short, in this case the researcher argues that the core of the Crossword Puzzle one of a "horizontal" and "vertical" word game that should be filled by the player. However, not only words can be made into Crossword Puzzles, but numbers, symbols or notations in mathematics can also be a Crossword Puzzle. This is what underlies the researchers raised this issue.

Crossword Puzzle allows students to learn optimally because it is fun and resembles word guessing. In addition, this strategy is also an application of an active learning model, so it is likely that students will remain active and interactive in following learning (Wijiastuti, 2013: 31; Muhtarom *et al.*, 2016: 21), can improve student learning responsibilities (Bonwell & Eison in Coticone, 2013: 33), establishing personal motivation and satisfaction, accommodating various learning methods, and enhancing decision-making capabilities (Muhtarom *et al.*, 2016: 21), and easy to teach, train students' accuracy or incidents in answering questions and sharpening the brain for critical thinking (Noviana & Rahman, 2013: 92; Ali & Endryansyah, 2015: 369).

Based on these advantages, overall, this model is able to create an active and interactive learning process, fun, motivating, and sharpen the brain and the ability of students who ultimately expected to improve learning outcomes. The disadvantage is if the Crossword Puzzle-shaped test is made non-continuous or related. So, students feel confused if they cannot answer one of the problems and it will affect the student's answer whose letters or numbers are related to the unanswerable problem. In addition, this model can only be given at the end of student learning (Ali & Endryansyah, 2015: 369). And, this model can also decrease student's creativity because they only accept incomplete lessons (Noviana & Rahman, 2013: 92).

Based on preliminary studies conducted by researchers, the model Crossword Puzzle is still not very popular in the world of education, especially on students, more specifically at the University of Balikpapan. In fact, students should not just give paper assignments, the lesson monotonous, only discussion and debate or other independent tasks, and the other occupy tasks. Occasionally, it is necessary for them to learn while playing, especially in the courses of expertise (non-educational courses) that tend to be monotonous and difficult for them.

To make crossword puzzle is easy. According to Silberman (Nafi & Sulisty, 2014: 39), to make crossword puzzle as follows: (1) Describe some important terms or names related to the subjects you have taught, (2) Arrange a puzzle (3) Prepare the crossword puzzle guide, (4) Distribute the crossword to the students, either individually or in groups, (5) Set the time limit, and (6) Give rewards to the individual or team who answers the most correctly. Adopting that explanation, the procedure used by the researcher in active learning with Crossword Puzzle model is as follows: (1) Lecturer make Crossword Puzzle first manually, (2) Lecturer make face to face with students, read rules of the game, and give limit (3) The lecturer explains some important terms or names related to the course of Geometry of Transformation, (4) Divides the students into groups (2 to 3 students each group), (5) Gives the Crossword Puzzle sheet, (6) Inviting students to work on the worksheet, (7) Interactively

discussing each question in the crossword puzzle, (8) Giving rewards to the group that answers the most correctly.

Through this strategy, students are expected to feel happy, because so far they have never received learning by using this model. In addition, this model is almost similar to playing a word or guess words. So, indirectly they will learn while playing with an interesting, creative, and innovative learning process. Pietarinen (Muhtarom *et al.*, 2016: 21) states the entertainment side of the game can motivate students in learning so that there is an increased understanding of the concepts contained in the game. Similarly, Davis *et al.* (2009: 5) mentions that the puzzle game can be perceived as a recreational activity that makes students feel enjoy in learning.

Based on the exposure, the researchers need to test the Crossword Puzzle game model in Transformation Geometry course of the 5th semester students of Mathematics Programme (Class A & B) University of Balikpapan. For that reason, the problem in this research is formulated as: How is the success contribution of Crossword Puzzle model for learning Transformation Geometry course, and also how the learning result obtained?

METHOD

The method of this research is experimental method with design One-Shot Case Study, where the design paradigm there is a group that was treated and then observed the result (Sugiyono, 2016: 74).

This research was conducted at the University of Balikpapan, where the subjects are the 5th semester students of Mathematics Programme Class A which amounted to 18 people and Class B which amounted to 30 people. For that, the students will be treated at the 14th meeting in the form of reviewing all Transformation Geometry lessons using the Crosswrod Puzzle model, where they will be divided into groups (2 to 3 people each group). After that, the lecturers and students discuss the game together to find out the learning outcomes and their responses through answers from the questionnaire provided.

To collect the data, researcher used documentation study, test (instrument about Transformation Geometry in the form of Crossword Puzzle), and questionnaire. The questionnaire used to find out the students' responses and the successful contribution of the Crossword Puzzle model to their learning outcomes (Sugiyono, 2016: 176). The instrument consists of 17 statements that have been tested its validity with Product Moment Correlation where the criteria is said to be valid if it has a correlation of $r_{hit} > r_{tabel}(0,285)$. The following test results of each instrument with the help of SPSS 18 software.

Table 1. Questionnaire Validity Results

Number of Questionnaire	Coefficient of r_{hit}	Description	Number of Questionnaire	Coefficient of r_{hit}	Description
1	0,692	valid	10	0,674	valid
2	0,759	valid	11	0,168	invalid
3	0,691	valid	12	0,709	valid
4	0,587	valid	13	0,747	valid
5	0,375	valid	14	0,727	valid
6	0,714	valid	15	0,732	valid
7	0,771	valid	16	0,591	valid
8	0,657	valid	17	0,758	valid
9	0,656	valid	18	0,598	valid

Based on the data, we can see that on the test results validity, the coefficient of number 11 is $0,168 < 0,285$ (invalid), so it must not used. Furthermore, 17 items of questionnaire (valid) are tested also reliability. Based on the test results with Alpha Cronbach, obtained r_{11} in the questionnaire of $0,923$. The following output r_{11} from SPSS 18 can be seen in table 2:

Table 2. Questionnaire Reliability Results

Reliability Statistics	
Cronbach's Alpha	N of Items
0,923	17

Based on these results, from 17 questionnaire questions that have been validated, it also shows that the questionnaire is reliable, with the value $r_{11} = 0,923 > 0,65$. Furthermore, the Crossword Puzzle learning model that is applied in the form of active and fun learning where the lecturer to review the Transformation Geometry lessons using the problem of Crossword puzzle challenge consists of 15 horizontal questions and 15 vertical questions, where the previous challenge has also been tested on the class others.

Furthermore, based on the discussion together after working on the Crossword Puzzle challenge, students' learning outcomes obtained are collected, then analyzed to determine the score of their achievement. The way to find out the results of learning Transformation Geometry through the score test of students group are based on the achievement of predefined scores of the campus, where the interval as follows:

Table 3.The Interval Assessment of Transformation Geometry Course

Interval of Assessment	Description
80 - 100	Very Good
70 - 79,9	Good
60 - 69,9	Good Enough
50 - 59,9	Bad
0 - 49,9	Very Bad

After that, the results obtained will be expressed in table form, so the data analysis technique used in this research is descriptive statistics. According to Sugiyono (2016: 147), descriptive statistics was statistics used to analyze data by describing or representing the data that has been collected as the way it was without intending to make conclusions that apply to the general. Thus, this study is not to test a hypothesis.

RESULTS AND DISCUSSIONS

In this section, three dimensions will be presented: 1) experiments or treatments, namely the implementation of learning in the course of Transformation Geometry with the Crossword Puzzle model, and 2) the results of the students test through the challenge of Geometry Transformation in the form of Crossword Puzzle. The following will be described in detail both of these things.

1. Implementation of learning with Crossword Puzzle model in the course of Transformation Geometry

Learning activities carried out in several stages, including:

- Lecturers prepare tools and materials (crossword puzzle instruments, questionnaires, and gifts)
- The lecturer conveys the motivation and learning objectives of Transformation Geometry
- Lecturers divide the students who attend into several groups and distribute instruments about Transformation Geometry in the form of Crossword Puzzle
- The lecturer conveys the rules of the game in answering the existing Crossword Puzzle with a time limit of 1 hour
- The lecturer explains some important terms or names related to the course of Transformation Geometry
- The lecturer distribute the Crossword Puzzle sheet to the whole group to do
- Lecturers invite students to finished on the worksheet
- Interactively discuss each question in the crosswords
- Lecturers gives reward to the most answered groups correctly.

Implementation of learning using Crossword Puzzle model takes place in an orderly, relaxed, active, and fun. As for the students questionnaire, it was learned with Crossword Puzzle was the first time in the class (something new and unique to them). This is similar to previous research findings, that the Crossword Puzzle is very unique in learning (Coticone, 2013: 36). The Crossword Puzzle model also allows students to actively participate in their learning process and challenge themselves to identify problems or gaps that exist in their knowledge through an interactive format (Coticone, 2013: 36).

Students also feel motivated, asking more questions from the Crossword Puzzle provided. On the other side, there are also students who feel more difficult when the Transformation Geometry test is changed its shape to Crossword Puzzle. They are not accustomed because the tests so far are used in the form of a description only. In addition, the one hour time provided was still not enough by some groups, so they have not time to finish it.

Nevertheless, critics and suggestions from students need to be accommodated for future research improvements. Based on the results of questionnaire analysis, in this case in the form of students responses and the contribution of learning success using Crossword Puzzle model, shows the percentage 75,29% than expected. This means that the Crossword Puzzle learning model are well used and accepted by students.

2. Implementation of Learning Achievement

After carrying out the learning activities with Crossword Puzzle model, then the lecturers conduct the discussion so that the students' learning outcomes will be obtained. Based on the achievement score of the results of the Crossword Puzzle test, the following results are obtained:

Table 4. The Learning Achievement of Class A

Groups	Score	Description
Group 1 (DL, SR, RA)	83,3	Very Good
Group 2 (RA, DSH, UH)	76,6	Good
Group 3 (E, VDM, ZI)	86,6	Very Good
Group 4 (KE, LD, RA)	90	Very Good
Group 5 (AAR, DA, IH)	96,6	Very Good
Group 6 (AE, SP, DAF)	90	Very Good
Number of Students		18
Average Grade		87,18

Table 5. The Learning Achievement of Class B

Groups	Score	Description
Group 1 (M & NS)	77,7	Good
Group 2 (MS & R)	83,3	Very Good
Group 3 (AAU & NR)	66,6	Good Enough
Group 4 (NS & MDA)	58,3	Bad
Group 5 (VSK & DM)	86,6	Very Good
Group 6 (AAT & F)	96,6	Very Good
Group 7 (SRA & KA)	70	Good
Group 8 (LN & NP)	70	Good
Group 9 (AGL & SA)	70	Good
Group 10 (SR & LA)	76,4	Good
Group 11 (A & MS)	50	Bad
Group 12 (S & ZT)	85,7	Very Good
Group 13 (R & N)	41,6	Very Bad
Group 14 (AP & MA)	80	Very Good
Group 15 (DN & ND)	80	Very Good
Number of Students		30
Average Grade		72,88

Based on these two tables, it can be observed that in all of the 6 groups of Class A students it is found that 5 groups are predicated Very Good and only 1 group with good predicate. The average class they reached 87,18 (Very Good). In contrast to Class B, it can be observed that in all of the 15 groups of students in grade B, there was 1 group with a predicated Very Bad, 2 groups predicated Bad, 1 group predicated Good Enough, and the rest predicated Good and Very Good. However, the average class is 72,88 (Good).

According to the researcher, the achievement is not maximal yet. As explained before, this is because students are a little awkward with new learning models for them, time limitations, and researchers are not maximized in applying the Crossword Puzzle model. In addition, there is also a striking difference where in the achievement of Class A there is no group whose value is below 70, while in Class B there are still a group with Good Enough, Bad, even Very Bad predicate.

Researchers assume that the Crossword Puzzle model applied in Class B is not as high as in Class A. In addition, the differences are also reflected in their classroom character, where Class A pure students are more superior than Class B students who are in fact the majority of workers. However, the factors of the difference cannot be confirmed because of the fact that in this research is not done Homogeneity Test and Test-T because not to test the hypothesis and measure the differences. However, the facts show the differences that exist for their average grade achievement as shown in Table 4 and 5.

Through learning Transformation Geometry with Crossword Puzzle model, obtained the average students learning outcomes that can be said high, namely predicated Good. Not much different from the exposure of researchers, other relevant research results also show this. The application of the Crossword Puzzle model in learning can be said to be more effective than conventional methods and there is a significant difference between learning using the conventional Crossword Puzzle (Babayemi & Akinsola, 2014: 12; Rakimahwati, 2014: 83). In addition, Crossword Puzzle provides a positive experience for students (Coticone, 2013: 36; Davis et al, 2009: 9). So, overall this model is very helpful and gives a positive effect for students (Davis *et al.*, 2009: 9).

Not only on math subjects, the application of Crossword Puzzle model on other subjects also showed positive results. The Crossword Puzzle model was found to be effective in Bio-Chemistry learning (Coticone, 2013: 36); learning of Basic Science (IPA) (Babayemi & Akinsola, 2014: 8), learning IPS (Wijastuti, 2013: 34), is effective in improving numerical skills (counting) of Kindergarten students (Rakimahwati 2014: 79).

Seeing this, researchers argue that this active learning model is not limited to space and time, not limited to a particular subject or field of study. However, according to the researchers there are several possibilities (factors) that cause the model Crossword Puzzle has not shown the achievement of learning achievement Very Good for students compared to the results achieved by previous researchers with subjects of kindergarten to high school students that in fact learning can be conditioned to be more fun. Unlike when they were in school first, now on campus, students have been accustomed to learning independently by composing papers, class discussions and presentations, as well as project tasks; it is rare to have fun learning like playing Crossword Puzzles, so they are awkward to experience the first thing for them; as well as the lack of time given in solving the challenge.

Furthermore, the application of learning using the Crossword Puzzle model is not only once given to students, but also need repetition. And, maybe the time limitation factor of research is also very influential. Therefore, in addition to applying learning with the Crossword Puzzle model, time management skills are also required, an understanding of the factors that influence learning, as well as supportive learning theories.

Teachers/Lecturers do not just go to class, explain the subject matter, and leave the class just like that. Teachers/Lecturers also need to be familiar with learning theories, psychological factors and characteristics of students, and the use of methods, strategies, and learning models. Nevertheless, the

trial of the Crossword Puzzle model in the Transformation Geometry course is well appreciated by the students, and gives good successful contribution, and the learning outcomes are good as the quality of the model is improved.

CONCLUSION AND SUGGESTION

Through this research, it can be concluded that the learning of mathematics especially in the course of Transformation Geometry by using the Crossword Puzzle model in the 5th semester students of Mathematics Programme (Class A & B) University of Balikpapan gives a good successful contribution, and their learning result is good (although not categorized Very Good).

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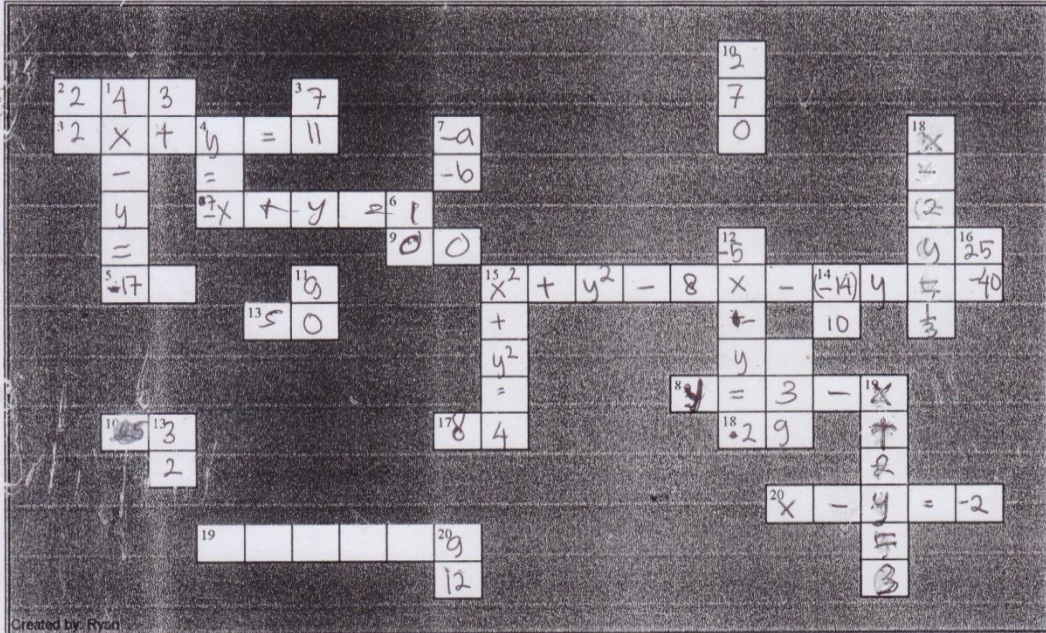
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ATTACHMENT

Here is the look of Crossword puzzles created by researchers:

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2. Fitriyani

TEKA TEKI SILANG MATEMATIKA MATERI "GEOMETRI TRANSFORMASI"



MENDATAR

- 1 Bayangan $A(-2, -3)$ oleh translasi $T = \begin{pmatrix} 6 \\ 6 \end{pmatrix}$
- 3 Bayangan $2x + y = 6$ oleh translasi $T = \begin{pmatrix} 1 \\ 3 \end{pmatrix}$
- 5 Bayangan $P(1,9)$ oleh refleksi $y = x$ $(9,1)$
- 7 Bayangan $x + y = 1$ oleh refleksi terhadap sumbu y
- 8 Bayangan $y = x - 3$ oleh refleksi terhadap sumbu x
- 9 Titik invariant
- 10 Translasi $T = \begin{pmatrix} a \\ b \end{pmatrix}$ dari $A(3, -4)$ ke $A'(5,1)$ $(2,5)$
- 11 Nilai y dari $Q(-7, y)$ jika direfleksikan oleh garis $y = -3$ menjadi $Q'(-7, -15)$
- 13 Bayangan $(0, -5)$ oleh rotasi $[0, 90^\circ]$
- 15 Bayangan lingkaran $(x - 2)^2 + (y + 4)^2 = 25$ oleh translasi $T = \begin{pmatrix} 2 \\ -3 \end{pmatrix}$
- 17 Bayangan $(3, -5)$ oleh rotasi 90° dengan pusat $(1,2)$
- 18 Bayangan $(2, 3)$ oleh dilatasi $k = 4$ dengan pusat $(2,1)$
- 19 Bayangan $2x - y = 3$ ditransformasi oleh matriks $\begin{pmatrix} 1 & 2 \\ 2 & 3 \end{pmatrix}$
- 20 Bayangan $y - x = 1$ oleh translasi $T = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$ dilanjut refleksi terhadap titik asal $(0,0)$

MENURUN

- 1 Bayangan $4x - y = 5$ oleh translasi $T = \begin{pmatrix} 2 \\ -4 \end{pmatrix}$
- 2 Bayangan $M(-3,0)$ oleh translasi $T = \begin{pmatrix} 5 \\ 2 \end{pmatrix}$
- 3 Bayangan $C(7, -11)$ oleh refleksi terhadap sumbu x
- 4 Refleksi dari $K(x, y)$ menjadi $K'(-y, -x)$
- 6 Bayangan $(-3,0)$ oleh refleksi terhadap garis $x = -1$
- 7 Bayangan (a, b) oleh rotasi $[0, \pi^*]$
- 10 $\frac{3}{2}\pi$
- 11 $\sin \alpha^\circ = 1$
- 12 Bayangan $5x + y = 2$ oleh rotasi $[0, 180^\circ]$
- 13 Luas segitiga $A(4,3)$, $B(4,5)$, dan $C(2,5)$ oleh dilatasi $[0, 4]$
- 14 Bayangan $(28, -20)$ oleh dilatasi $[0, -\frac{1}{2}]$
- 15 Lingkaran berpusat di O dan berjari-jari 2
- 16 Bayangan $(-5,8)$ oleh dilatasi $[0, -5]$
- 18 Bayangan $x - 2y = -1$ oleh dilatasi $[0, -3]$
- 19 Bayangan $y = 2x - 3$ oleh rotasi $[0, \frac{\pi}{2}]$ dilanjut dilatasi $[0, 2]$
- 20 Bayangan $(1,3)$ oleh translasi $T = \begin{pmatrix} 2 \\ 1 \end{pmatrix}$ dilanjut dilatasi $[0, 3]$

Selesai 29 soal

B = 29

Fig 1. One of The Results of The Student's Crossword Puzzle