

EFFECTIVENESS OF GAMES FOR LEARNING MULTIPLICATION IN SECOND GRADE OF PRIMARY SCHOOL

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ABSTRACT

Generally, mathematics learning achievement of Indonesian students cannot be assumed "good". One of the reasons is the learning of mathematics at the elementary level. There are many teachers, who teach mathematics, use mathematics only as a set of numbers and formulas, less using of props, and students lack the excitement in learning math. This study is an experimental research. Games used are: bowl and candy games, puzzle multiplication, red and white multiplication game, and snakes-ladders math game. The results showed the experimental class had an average value that is higher than the control class. Qualitatively, the experimental class can solve problems more quickly, and have a positive attitude towards mathematics better than the control class.

Keywords: *mathematics, game, multiplication.*

A. INTRODUCTION

TIMSS (Trends in International Mathematics and Science Study) is an international study of mathematics and science achievement of junior high school students. The results showed that the average mathematics achievement scores of students of class VIII Indonesia are significantly below the international average. In 1999, Indonesia was ranked 34th of 38 countries, with a score of 487 (the international average score of 487). In 2003, it was ranked 35th of 46 countries, with a score of 411 (the international average score of 467). In 2007, it was 36th ranked out of 49 countries, with a score of 397 (the international average score of 500). In 2011, it was ranked 38th out of 42 countries, with a score of 386.²

¹Puspendik, Survei Internasional TIMSS, <http://litbang.kemdikbud.go.id/index.php/survei-internasional-timss>, accessed in December 10, 2012.

²Kompas, Prestasi Sains dan Matematika Indonesia Menurun, <http://edukasi.kompas.com/read/2012/12/14/09005434>, posted in December 14, 2012, accessed December 20, 2013.

Is the math skills of Indonesian children that low? Father of Indonesian Mathematics Olympiad, Prof. Yohanes Surya, said that no child is stupid. In reality, children do not know how to learn and have not found a suitable teacher. Each child can certainly learn mathematics. Another reason that sometimes makes students lazy to learn mathematics is the lack of knowledge about the benefits of the material they are learning and the relevance of mathematics to the experiences they have ever had. Teachers assume mathematics as only a collection of formulas and algorithms.

There are still many classroom teachers who teach mathematics in MI in the conventional manner. Teachers explain, question and answer, give example problems, and provide some works to do. The teacher does not give students any chance in discovering concept / formula. Teachers also use less media/visual learning. Learning mathematics is also less providing space for recreation and creativity.

Based on the testimony of teachers, many students have not been so good in performing multiplication calculations. Based on the curriculum, elementary school second grade students should have understood and been able to perform calculations with the results of multiplication under 100. They are supposed to use it in solving simple problems. If the reality shows that the curriculum requirements have not been done, so the students' ability in understanding further mathematics will be hampered.

Some activities and games used in learning math multiplication material is used in this study. Then an experiment to see if the game and the props used in learning effective and fun for students is conducted.

B. THEORITICAL APPROACH

The Characteristics of Elementary students

According to Piaget³, the cognitive development of primary school age children (ages 7-11 years) is the real operational stage. The child is able to understand the "operation" in a real situation, but have not been able to solve abstract problems in this stage. The use of the surrounding real objects will help children in understanding math concepts.

The students in elementary school age have the typical characteristics. By identifying the characteristics, the teachers are expected to be able to apply the appropriate instructional methods to their students. These characteristics are: like playing, moving, having teamwork, and doing something directly.

By such characteristics, the teachers is demanded to design such learning activities which contains games, teamwork, and student activities. For elementary students, the students will understand the teacher's explanation about the subject matter better understood if the teacher gives students the opportunity to do it themselves and be directly involved in the learning process.

³John W. Santrock, *Psikologi Pendidikan*, 2nd edition, (Jakarta: Kencana Prenada Media Grup, 2007), p.47-54.

The Psychology of Mathematics Learning

Here are some theories related to the study of mathematics⁴:

Thorndike's theory

Learning theory of Edward L. Thorndike (1874-1949) is well-known as the stimulus-response theory. It states that learning is essentially the process of establishing relationship between stimulus and response. Exercise, which is often carried out on learning basic math, in principle using stimulus and response that will have a strong relationship if the repetition is frequently done. However, the repetition which has positive impact is the regular frequented, it is not boring, and performed attractively.

Gagne's theory

According to Gagne⁵, there are two objects will be obtained in learning math: the direct object and indirect object. Indirect objects are the ability to investigate and solve problems, self-learning, positive attitudes towards mathematics, and to know how they should learn. The direct objects are facts, skills, concepts, and rules of mathematics.

Bruner's theory

Bruner said that⁶, children should be given the opportunity to manipulate objects (props) in the process of learning. With props they use, the children will know how the objects' structure regularity. Bruner so recommended children's fully activeness in the learning process.

Bruner argued that the children pass through three stages in the learning process: (1) The enactive phase. The children are involved directly in manipulating (fiddling with) objects by this stage. For example, children count the sweets they were carrying. (2) The Iconic phase. The children begin to use a picture of an object at this stage. For example, candy is replaced with the image dots only. (3) The symbolic phase. The children begin to use the notation / symbols / emblems. For example, five pieces of candy is replaced with the notation 5.

Gestalt's Teory

This theory says that in the mathematics learning, the teachers should pay attention to the following matters: (1) Presentation must mainly focus in understanding the concept. (2) The learning process should notice the intellectual preparedness of each student. (3) Set the class to such atmosphere so the students will feel comfortable in learning.

From the three followings, the teachers should not only give the concept/formula as it is in performing the subject, but they should be more concerned with the understanding of the process the concept/the formula formation. In the learning of mathematics at the elementary school level, it should start from the real/concrete, to the semi- concrete and to the abstract concept. Exercise about numeracy skills in mathematics is very essential, but must be done after the skill is mastered.

⁴Erman Suherman, dkk, *Strategi Pembelajaran Matematika Kontemporer*, (Bandung: Universitas Pendidikan Indonesia, 2003), p.28-31.

⁵Erman Suherman, dkk, *Strategi ...*, p.33.

⁶Erman Suherman, dkk, *Strategi ...*, p.43.

Playing activities and Games

The children's life is really close with playing. In the past, children playing was assumed wasting time, especially if the children had entered a period of formal schooling. Children were expected to learn more. They only could play on weekends. However, the opinion about playing activities has changed at the present time. Playing activities is considered as a valuable learning experience.

Playing is an activity for having fun without considering the final result. A similar activity can mean working for parents, but it is also meant as playing for children.⁷ The game can be used to teach and reinforce understanding of concepts in mathematics with good design and planning.

Operation Multiplication Numbers

Based on the Indonesian curriculum, the multiplication material began to be taught in the second grade elementary school. There are three definitions of multiplication⁸.

Definition 1: Repeated Addition (Repeated - Addition Approach)

If a and b are integers and $a > 0$, then $a \times b = b + b + \dots + b$ (as many as a foot). If $a = 1$, then $a \times b = 1 \times b = b$. If $a = 0$ then $0 \times b = 0$ for all b . In this case a and b are called factors.

Definition 2: The composition of the rectangle (Rectangular Array Approach)

If a and b are natural numbers, then $a \times b$ is much element / elements in the rectangular arrangement consisting of a row and column b .

Definition 3: Product of the Cartesian product (Cartesian Product Approach)

Suppose a and b are natural numbers. If $a = n(A)$ and $b = n(B)$, then $a \times b = n(A \times B)$.

In the mathematics learning in primary schools, the definition used is the definition of multiplication 1, ie multiplication as repeated addition. This definition can only be used for the multiplication of a positive number times to a positive number, or a positive number times a negative number. In this definition, 3×5 can be described as the number of oranges in 3 baskets, with each basket contains 5 oranges.

C. RESULTS AND DISCUSSION

This research was conducted in MIN Yogyakarta II. The experimental class was class II B. The control class was class II A. The class teachers did the class learning control as they did in the regular class. The games and worksheet designed by the researchers were used in the experimental class learning.

The effectiveness of these games in learning can be judged from the results of the test/ evaluation of students. It was done twice. Data of learning outcomes was the cognitive aspect, it was score /

⁷Elizabeth B. Hurlock, *Perkembangan Anak*, (Jakarta: Erlangga, 6th edition, 1978), p. 320.

⁸Gary L. Musser & Blake E. Peterson, *Mathematics for Elementary Teachers, a Contemporary Approach*, 9th edition, (USA: John Wiley & Sons, Inc, 2011), p.104-105.

value evaluation test in the quantitative aspect, it was the way they work on the problems and how to solve the problem fast in the qualitative aspect. Learning outcomes in the affective and psychomotor aspects of qualitative data was a willingness for self-learning and a positive attitude towards mathematics. The data were analyzed qualitatively and quantitatively.

To differ the outcomes of the experimental class and the control class, a comparative analysis using the “t test” hypothesis was conducted:

H_0 : there was no significant difference between the average value of the experimental class and the average value of the control class .

H_a : There was a significant difference between the average value of the experimental class and the average value of the control class .

Stages of Learning and Used Games

In mathematics in elementary school, there are basically two stages to go through: the building concept stage and the skill development stage⁹.

1. Building Phase Concept

For multiplication building concept as repeated addition used “candies and bowls” game. The equipment used was a bowl and buttons or colorful seeds as candy. A set consisted of a piece display of small plates, 20 pieces of colorful seeds, and 5 fruit bowls.

This activity was not actually a game, but the students’ activity in understanding the concept of multiplication as repeated addition. By using this figure, the multiplication 3×4 means “there are three bowls, each bowl contains 4 candy”. Because the name of the game “candies and bowls” the students were expected to remember easily that $3 \times 4 = 4 + 4 + 4$.



Figure 1. A set of props “candies and bowls”

This model was equipped with Worksheet 1 (LK 1) in learning. The props were used along with Worksheet, so the students were able to learn mathematics in phases, from enactive (concrete), iconic (semi-concrete) and symbolic (abstract).

⁹ Heruman, *Model Pembelajaran Matematika di Sekolah Dasar*, (Bandung: Remaja Rosdakarya, 2010), p. 2-3.

The teacher used display and worksheets in experimental class. It resulted that most of the students could use the display correctly. The teacher used pictures on the board in the control class, and students did the exercises in the book.



Figure 2. The use of props “candies and bowls” and LK 1

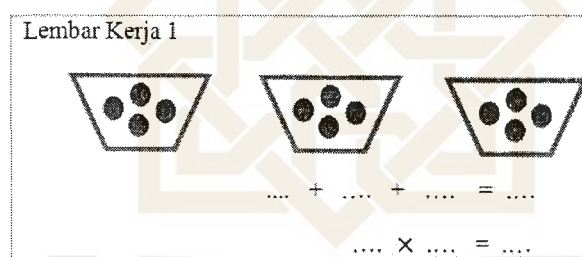


Figure 3 . Example question on LK 1

The students were asked to do Worksheet 2 (LK 2) in the next stage,. Example question on LK 2 can be seen in the following figure:

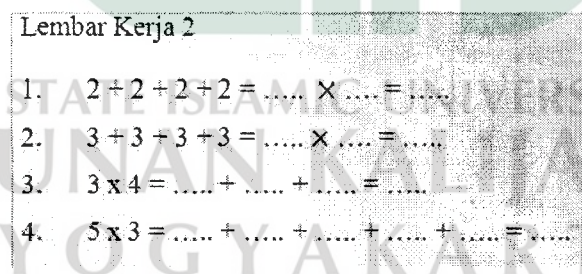


Figure 4 . Example question on LK 2

The students were taught to understand that the “ bowl “ and “ candy “ can have a variety of forms/meanings by using Worksheet 3 (LK 3) after they understood the concept of multiplication as repeated addition using props and candy bowls. The repeated addition was no longer used in understanding of multiplication in worksheet 3, multiplication was introduced as 1×6 which can not be explained through the repeated addition concept.

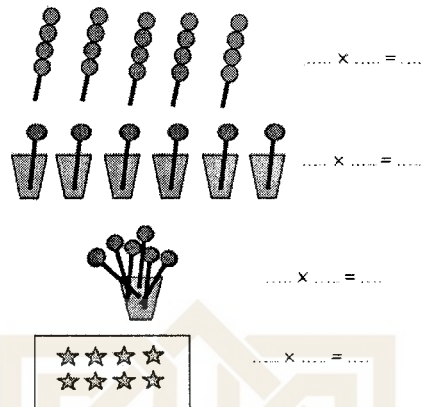


Figure 5 . Example question on worksheet 3

Skills Development Phase

2. Skills Development Phase

The researchers designed 3 kinds of games to strengthen students' understanding and skills as a way to train students perform multiplication calculations. The goal was to improve the skills of students to calculate the multiplication results in a fun way and according to their speed. The games are:

a. Multiplication Puzzle

This puzzle was made from ordinary puzzles that are sold in every stores. It was modified so that it became a medium of learning. The modifications were by giving number of multiplication result in each piece of the puzzle, and multiplication number was placed on the puzzle board. Students were required to put the pieces of puzzle in the appropriate place, based on the multiplication and the results. Teachers used this game at the end of the lesson.

It resulted the students' enthusiasm in doing the game. Based on interviews with the teachers, they were satisfied with this game. They did not need to make practice questions and the students would learn by themselves.



Figure 6 . Multiplication puzzle game

Multiplication Game Red and White

b. Red-white multiplication game

This game needed a board game made of thick paper, two dices, and buttons with 2 or 3 colors for each color is 10 pieces. 2 or 3 students could play a set of these games. There were two kinds of dice, red and white. White dice had numbered 1 to 6, the red one had numbered 4 to 9.

This game was made in 3 versions. The first was for the multiplication of $1-6 \times 1-6$. The second one was for $1-6 \times 4-9$. The last version was for $4-9 \times 4-9$. The student could choose which version they want to play. Teachers also could use this game in learning, according to the material that students have learned in class.



Figure 7 . Three red and white version of the game

Rules of the game :

1. This game can be used for 2-3 players.
2. Prepare 10 buttons for each player. Each player takes the buttons with different colors.
3. Shuffle a dice along the other one. Watch for the appearing numbers. Times the appearing numbers each other and put the button in appropriate numbers. Do it one after another
4. If one of the student can not calculate the result, or the multiplication result is covered by the buttons, he lost his chance.
5. The winner is the one whose buttons are gone.
6. The teacher can modify the rule of the game as well as the learning demand. The students also can modify it in accordance with the agreement.

This game had same main purpose with the red-white puzzle game. It was to improve the students' skill in calculating the multiplication result. It differs in the number of the player. The puzzle game was intended for individual play (solitary). The red and white of this multiplication was intended to be played with 2 or 3 people. The students' social interaction will improve by doing this game with peers.

The teachers used this game in the early learning hours as a review in the experimental class. They used it in the final learning hours for strengthening students' math skills. Students were enthusiastic and actively involved in learning. Students also used this game at the break.

3. Snakes and Ladders Maths

The game was like a game of snakes and ladders. It was modified as well so the students could learn while playing well at the same time. The modification was adding cards to be answered by the player.

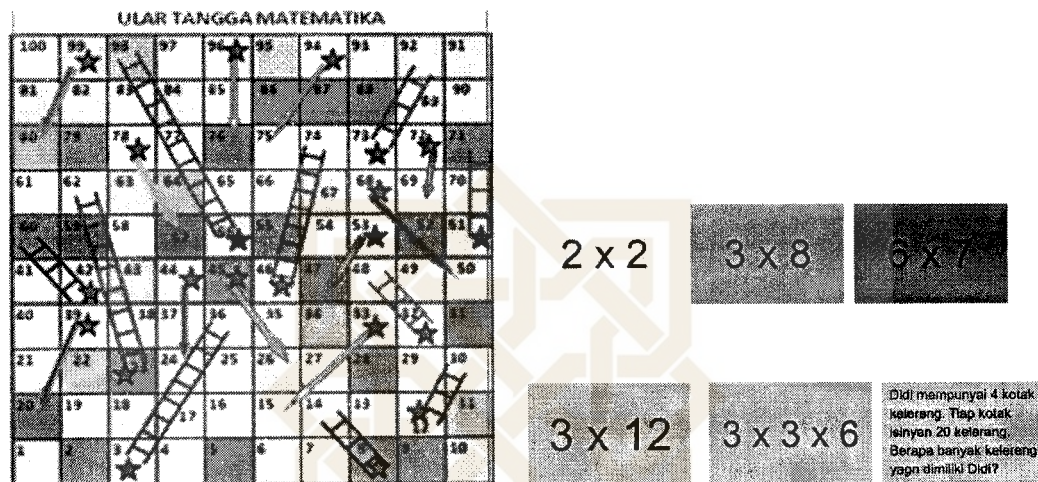


Figure 8 . Snakes and Ladders game that has been modified and sample card

Rules of the game:

1. This game can be played for 3 or 4 students .
2. Players raffle for the playing turn, the winner is the first to go.
3. Shuffle the dice, and place a pawn on the appropriate box.
4. If a player is on the stairs or in the snake, he will get a red star then. Players must take the provided cards, and answer the questions.
5. If a player is on the ladder path and can answer the question correctly, he may go up then. He may not go up if his answer is wrong.

If a player is in the snake path and can answer the questions correctly he does not go down. If the answer is wrong, he should be dropped.

6. The winner is those who get the initial box 100 firstly.
7. The teacher can modify the rule of the game as well as the learning demand. The students also can modify it in accordance with the agreement.

Based on observations made during break time, the researcher found several groups of students performed game of snakes-ladder and red-white multiplication game. The researchers had interviews with students while the observation time. They showed they love this game.

Analysis of Student Results

The followings are the data on learning outcomes of students in the experimental class and the control class. The number of students in the control class were 26 students. The students of experimental class were 27 students. The results are as the followings:

Table 1.

Summary of results of tests I and class II test control and experimental class

Class	Value of Test I			Value of Test II		
	Average	Lowest	Highest	Average	Lowest	Highest
The control class	6,99	2,7	10	7,17	2,5	10
The experimental class	8,02	4	10	8,67	4	10

If the deviation standard is calculated, the following results are:

Table . 2 . Summary of the average value and standard deviation of the results of the test I and test II for the control class and experimental class

Class	Test I		Test II	
	Average	Deviation Standard	Average	Deviation Standard
Kelas Kontrol	6,99	2,56	7,17	2,44
Kelas Eksperimen	8,02	1,67	8,67	1,76

The table showed that the experimental class had higher average score than the control class. The standard deviation in the experimental class is smaller than the control class. It meant that the values obtained in the experimental class is more homogeneous than the value obtained in the control classes .

By the qualitative, The experimental class students' speed in doing the multiplication was faster than in the control class students'. According to researchers, the experimental class students often repeated the calculation of multiplication by playing the math games. The more students in the experimental class occasionally performed multiplication calculations by giving this game, so that the obtained evaluation results was also better.

Based on observations and interviews with the teachers and students in the experimental class, the students have a positive attitude toward math. The students mostly said that they liked mathematics. Every time the teacher offered students to answer the questions or would write the answers on the board, they raised their hands.

The students played this games at the break time and in the morning before the learning starts. They took the game from the shelf themselves. They helped their friend who had not been able to. They also seemed aware if there was a friend who had not been deft performing the calculations.

According to researchers, this was why the experimental class had higher test result and smaller deviation standards than the control class.

From the results of the test “t” is obtained : $t_{hitung} = 2,34$. With degrees of freedom $= N_1 + N_2 - 2 = 24 + 27 - 2 = 49$, by taking a 5 % significance level, the value $t_{tabel} = 2,01^{10}$. Because $t_{hitung} = 2,34 \geq t_{tabel} = 2,01$, then H_0 was rejected and H_a was accepted. That meant: there was a significant difference between the average value of the experimental class and the average value of the control class, in this case means the average value of the experimental class is higher than the average value of the control class.

As Gagne ever explained his opinion, The study of mathematics will obtain the two objects: the direct object and indirect object. Indirect object is the ability to investigate and solve problems, self-learning, positive attitudes towards mathematics, and know how they should learn. Direct objects are facts, skills, concepts, and rules of mathematics. These objectives can be achieved by using these games in learning multiplication in the second grade of elementary school. Students take their game devices in the classroom and invite friends to play. This proves students have practiced for self-learning.

Observation results show, students will play the game enthusiastically at the first 10 minutes. After 10 minutes they had changed to another game. When the researchers gave the game for the first time, the enthusiasm of the students was very high. The students selected a new game when they were given the new one. After a week passed, the students' enthusiasm grew higher. But two weeks later the students were already getting bored. Since the students have already mastered performing multiplication calculations, and this game became less challenging.

Since children can quickly get bored quickly and easily switch their attention, the teacher should be so creative that the enthusiasm of student in learning can be maintained. The teacher also should always motivate the students to use and choose an useful game.

CONCLUSION

1. The learning model to establish the multiplication concept is “candies and bowls” game. It is played while doing the worksheet. The puzzle games is the next turn. Then red-white multiplication and the snakes-ladders game. It is proven very effective in the process of learning mathematics for the second grade elementary school. It is proven that the experimental class had higher average value, can work on the problems more quickly, and have a positive attitude towards mathematics better than the control class.
2. According to students of the second grade in experimental class B, the game is fun and makes them always learn. The results of observations show the students use these games at break time and before the school starts.

¹⁰Anas Sudijono, 2012, *Pengantar Statistik Pendidikan*. Jakarta: Rajawali Press, p. 405.

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