A Comparative Study: Concept Number Skills of Children Aged 4-5 Years after Playing Two Different Games

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Abstract. Mastering mathematics for preschoolers is essential because it will make children become more skillful in solving problems. Currently, learning number concepts becomes easier because the smartphones have provided the games, including “Belajar Angka” and “Marbel Belajar Berhitung”. Games used to introduce the concept of numbers to children mostly in two kinds, text games, and illustrative games. A text game used many symbols, while an illustrative game used images of concrete objects. This study aimed to determine the understanding of the concept number skills of children between a text game and an illustrative game in learning through mobile games. This study used a quantitative approach. 20 children who are 4-5 years old were participated and they were divided into two groups. A test was involved to obtain information about the concept number skills of children. The results showed that the illustrative game was significantly better in improving the understanding of the concept of numbers through pre-test and post-test comprehension, t(18) =2.855, p = 0.011. This paper also discussed the design of each game.

1. Introduction

Early age is an appropriate time for children to open their horizons about the surrounding phenomenon leading to the concept of mathematics [1]. Mathematics for early childhood is a way of looking at the children in seeing, experiencing, and understanding the environments around them. Therefore, learning mathematics for children is not only learning numbers, but it can include counting, sorting, measuring, building and describing shapes, finding patterns, estimating, among other experiences. Learning mathematics for children is important because it will make children become more skilled in solving problems in the future.

Mathematics mastery at the early stage is really crucial and becomes the indicator of the advanced mathematics achievement and mastery [2]. Experiences and knowledges obtained by children on mathematics during their preschool will create important foundations for their experiences in primary education [3]. The child’s skill in understanding the concept of numbers is the ability to understand the value of small quantities rapidly, making decisions about the numbers and values of numbers (i.e. 4 close to 3 compared to 6) [4]; understanding the count principle (i.e. the symbol of number indicates number of objects); and combining and separating sets (i.e. 3 and 2 will be 5, and 5 can be split into 2 and 3). The Ministry of Education and Culture Law Number 137 in 2014 on the National Standard of Early Childhood described that the children’s ability aged 4-5 years in recognizing the concept of numbers at least includes the ability in: (a) spelled out many objects, (b) recognizes the concept of numbers, and (c) recognizes the number symbols.
The introductions of the concept of numbers in preschool are still done by conventional methods such as a story telling, question and answer, assignment, and direct practice. In fact, today's technology is growing rapidly on all fronts, one of them is the smartphone. Most children are adept at playing smartphones for recreational purposes rather than educative purposes. Currently, many smartphone users in the world reached 1.86 billion or about 25.7% [5]. From the population of children around the world, early childhood was already starting to use the smartphone that is equal to 63% [6]. When viewed from the side of its usage, the most widely used smartphone is to play game, which is equal to 39% [7]. Viewed from groups of children under 8 years old, 7% use handled video game, and 6% use video game console [8].

Game is a physical or mental contest based on special rules with the aim of entertaining and rewarding the players [9]. Game based learning is the use of game to support learning process [11]. It is not an enemy to be avoided, as it provides the best chance of involving the child in the actual learning process [13]. As a learning media, the use of games is very useful, because games can enliven learning topics and are very effective in handling problem solving [14].

Currently, the development of game for children has been faster than before [15]. In quantity, the number of games for early childhood is more easily accessed by smartphone. The number of educational games has increased significantly but limited studies in assessing its effectiveness and validity [16]. Early childhood has been introduced to the concept of numbers [17]. To teach the concept of numbers in children aged 4-5 years, researchers found two types of games developed by application providers, namely games supported with the illustration of objects and games supported with using the symbol. Through this research, researchers analyses two types of games and compare their effectiveness in improving the skills of children to know the concept of numbers. The research questions are as follows:

a. Which game that is more effective for improving concept number skills of children aged 4-5 years old?
b. Why is that game effective in improving the child's skill to recognize the concept of numbers?

2. Method

2.1 Design
This study used an experimental method with two groups. Each group got the different manipulation. Before the manipulation was done, the measurements were done in both groups (pre-test), and the manipulation effect was measured in both groups (post-test). The selection of subjects in both groups used randomization so that the subject conditions in both groups were equivalent [18]. The randomization criteria were children aged 4-5 years.

2.2 Instrument
Measurements aimed to assess the skill of children to understand the concept of numbers. Measurements were made using a test that have been validated by the expert with the Cronbach alpha score, which shows the number 0.82 indicating the instrument is included in either category [19].

The skills to recognize the concept of numbers measured consisted of four indicators i.e: (1) knowing the concept of many and little, (2) calculating coherently, (3) calling the symbol of the number, and (4) calling the number symbol corresponding to the number of objects. The range of scores for each indicator was: (1 = Not Developed), (2 = Beginning), (3 = Expanding According to Expectations), and (4 = Very Good Develop). The overall maximum score of the indicator is 16.

Text-based games are represented by “Belajar Angka”, a game developed by Solite Kids, while illustration-based games are represented by “Marbel Belajar Berhitung”, a game developed by Educa Studio. “Belajar Angka” game was a series of educational applications for children under the age of 8 that aimed to help children learn about basic numbers. There were two features in this apps, learning and playing. Learning features consisted of learning basic numbers (0-9), learning teens and dozens (10-99), studying numbers hundreds (100-900), learning the numbers of tens thousands and hundreds thousands, and learning millions. The play features consisted of playing magic number lamps, playing number trucks, playing bianglala, playing figure dolls, playing fish ponds, playing exciting numbers, and playing shooting meteors. “Marbel Belajar Berhitung” game has characteristics using illustrations in the form of pictures of
objects in the delivery of material, such as flowers, balloons, and others used to guide children in understanding the concept of numbers. Because of the limitations of space in displaying the objects that exist, then the calculation of objects only until the number 9. In addition, the assessment parts of the game also used the illustration of objects, by calculating the existing objects there and choosing the right answer. The differences of games’ display were shown in Table 1.

| No. | Component          | Text Game | Illustrative Game |
|-----|--------------------|-----------|-------------------|
| 1   | Opening            | ![Text Game](image1) | ![Illustrative Game](image2) |
| 2   | Introducing the numbers | ![Illustrative Game](image3) | ![Text Game](image4) |

2.3 Procedure
Subjects in this study were 20 children aged 4-5 years in kindergarten ABA Kalimundu, Bantul Regency, which was divided into two groups. The subject selection requirements should never use a smartphone before. They were divided into 2 groups, an illustrative game and a text game groups. The flow of this research included: (a) giving the pretest, (b) introducing how to play the games, (c) learning with the games (the concept of many and little, number of objects, symbols of numbers), and (4) giving a postest.

The skills to recognize the concept of numbers were given before and after learning by games. The test involved four main indicators, i.e., knowing the concept of many and little, calculating coherently, calling the number symbol, and calling the number symbol corresponding to the number of objects. It divided into 32 question items (8 questions for each indicator). The total value will then be categorized according to four categories, namely Very Good Developed (12-16), Expanding According to Expectations (8-11), Beginning (4-7), and Not Developed (1-3).

2.4 Data Analysis
This research used two kinds of tests including a normality test and a hypothesis test through SPSS.21. The normality test aimed to decide the distribution of data and establish the statistical techniques that should be used in the next step. The next step was using a One Kolmogorov-Smirnov Test method with a significance level (α) 5% or 0.05. Hypothesis test used to obtain the differences of concept number skill level before and after using a game in each group. Independent Sample t-Test was used to test the hypothesis.

3. Result and Discussion
3.1 Result
Most of the participants in this study were boys (n = 12, 60%), and the rest of the participants were girls (n = 8, 40%). Normality and homogeneity tests were performed for pre-test results from both groups. Based
on the result of pre-test value, both groups showed there was no significant difference of value. This suggests that the pre-test data in both groups is normal and homogeneous. Furthermore, based on post-test results shows that games with the illustrations were better than games with the text. Full pre-test and post-test results were shown in Table 2.

|  | Mean | N  | Std. Deviation |
|---|------|----|----------------|
| **Text Game** |     |    |                |
| Pre-test       | 8.5  | 10 | 1.95789        |
| Post-test      | 10.1 | 10 | 1.66333        |
| **Illustration Game** | 8.4  | 10 | 2.54733        |
| Pre-test       | 12.8 | 10 | 2.48551        |

Based on the result of pretest, the average score of the group with the text game was 8.50 with the standard deviation of 1.95789, and group with the illustrative game was 8.4 with the standard deviation 2.54733. The postest results obtained the average value of the text game group of 10.1 with the standard deviation 1.66333, while the illustrative game group of 12.8 with a standard deviation of 2.48551.

Based on Table 2, it shows that post-test score in the group of illustrative game is higher than the text game group. The results of pre-test and post-test in both groups then analysed by using One Kolmogorov-Smirnov Test, and data is normally distributed and homogeneous. The next analysis is t-test by using Independent Sample Test. From Table 3, it appears that the indicators of knowing the concept of many and little, calculating coherently, calling the symbol of number is less significant in the both groups. But on the indicator, the number symbol corresponding to many objects showed a significant difference (d = 1.3).

| Indicator | Score | Deviation |
|-----------|-------|-----------|
| Text Game Group | 2.7   | 0.5       |
| Illustrative Game Group | 3.2   | 0.6       |

### 3.2 Discussion
The results of this study indicate that, based on post-test results, the skills to comprehend the concept of numbers in the illustrative games was better than the text game with a balanced pre-test score. Of course, illustrative games could be said to be more effective in improving the ability of understanding the concept of numbers. The quality of educational games for early childhood was certainly influenced by the suitability of games on the principles of educational games. Miller & Kocurek argued that the principles of developing educational games for early childhood including: (a) game compatibility with child development, (b) fitness of games with learning objectives, (c) facilitating diversity, and (d) game compatibility with the principles of play [16].
Belajar Angka | Marbel
---|---
1. Compatibility with child development | Fine motor | S | S
   | Cognitive | LS | S
   | Language | S | S
2. Compatibility with the learning’s goals | - | LS | S
3. Facilitating diversities | - | S | S
4. Compatibility with the play’s principles | Spontaneous | S | S
   | Volunteer | S | S
   | Interesting | LS | S
   | Get rewards | S | S

Note: VS: very suitable, S: suitable, QS: quite suitable, LS: less suitable, NT: not suitable.

Based on Table 4., it showed that an illustrative game has fulfilled the principles in developing games compared with text game. First, the illustrative game was appropriate better than a text game in the cognitive development of children aged 4 to 5 years old because it was using concrete objects as a material to convey the concept of numbers. According to Jean Piaget, the children aged 4-5 years old was still at the pre-operational phase. Children at this stage requires concrete materials to help them in the learning process [20]. Furthermore, in teaching the concept of number to children has to consider the three phases of the process including the use of concrete objects, then gradually replace them into images representing objects, and finally to an abstract level using numbers and symbols [21]. An illustrative game has involved images representing concrete objects (flowers and balloons) to count, before displaying the numbers. In contrast, a text game directly displays the symbol of the numbers.

Both games have also considered the fine motor skills of the children, and also stimulate the "tap" gesture. The illustrative game has involved slide, drag, and drop gestures for children. Basically, children aged 4-5 years have mastered 7 basic movements (seven fundamental gestures), namely: tap, flick, slide, drag and drop, rotate, pinch and spread [22]. Educational games should pay special attention to the intended audience, which should dictate the level of communication and in particular, the language used in the game [16]. Both games have a child-friendly language, such as passing one command at a time.

The games have facilitated children’s diversities from the gender perspective. They involved objects that were liked both of boys and girls, i.e. fishes, flowers, lamps, and trucks. The games also made children felt interested and introduced to the modern technology, so the children would explore by themselves [23]. The learning purposes of illustrative game were also more relevant than the text game. It focused on the introduction of the concept of numbers in more depth by giving meanings to many objects and the concept of numbers, while the text game focused on the introduction of the symbol of numbers. Actually, to recognize the numbers well, firstly children had to understand the numbers 1 to 10, then the children could be developed in the higher level. The use of illustrations in the form of concrete objects would be more interesting to the children than using number symbols alone without knowing the meaning. An illustrative game group was more excellent in calling the number symbol corresponding to the number of objects. It was influenced by the characteristics of the games, and if the illustrations involved in teaching concept number skills, it would give the children the meaningful senses [23].

4. Conclusion
The concept number skills of children aged 4-5 years old in the group of an illustrative game are higher than in the group of a text game. One of the indicators, the symbol of number corresponding to the number of objects, has a significant difference in both groups. However, the other three indicators are a less significant of both. Overall, the illustrative game had occupied the principles of developing game, and the text game was less meet the principles of developing game.
Parents or teachers could be used these games in learning number concepts if they have complied the principles of developing games for children. For the game developers, they should consider the principles of developing games in making games for children.

5. Acknowledgement

Acknowledgment is conveyed to all participants of this study.

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