A New Tool to Facilitate Learning Reading For Early Childhood

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ABSTRACT

This paper proposes a new android application for early childhood learning reading. The description includes a design, development, and an evaluation experiment of an educational game for learning reading on android. Before developing the game, Unified Modeling Language (UML) diagrams, interfaces, animation, narrative or audio were designed. Hardware and software requirements were also determined. After designing the game, 2D objects were created according to the interface design. After that, the animation and narrative or audio were created on these objects according to the animation and narrative or audio design. The animation given to these objects included translation, scaling, and rotation. To give an action on the objects, ActionScript 3.0 was added on them. Twenty-six kindergarten pupils have participated in this evaluation experiment. They were divided into two groups, namely. an experimental group that learned with the developed android educational game and a control group that learned with a reading book. The result of development game is a 2D educational game that applied the *Belajar Membaca Tanpa Mengeja* (BMTM) method. The game contains the rules, goals and objectives, outcomes and feedback, challenge, interactions and representations. The experiment results show that the post-test mean score of the experimental group is higher than that of the control group (the experimental group scored 18.92 while the control group scored 9.38) and the Gain score of the experimental group is 0.39; this score is in medium category. Finally, the android educational game can increase student's reading ability, in the medium category. So, the developed android educational game is a better alternative tool that can be used by early childhood pupils for learning reading.

Keywords: educational game, mobile device, android, method of learning reading, early childhood

INTRODUCTION

Reading is one of the skills needed by children, especially for children who will continue study in elementary school (Noviana, 2013). Kindergarten pupils are introduced to reading skills. The introduction of this reading is not taught directly as their own learning to children, but through playing approach (Dikdasmen, 2009). According to Lely Tobing Mont, playing not only trains physical development, but also the brain; stimulation of the brain occurs when children play and this will develop their problem-solving skills, language skills, sharpening logic, as well as other basic concepts (Syamsuddin, 2014).

One method that can be applied for learning reading is a Learning Reading without Spelling method or in Indonesian: "*Belajar Membaca Tanpa Mengeja*" (BMTM). The BMTM method is taught to children through playing approach (Noviana, 2013). The method is in accordance with the principles of

implementation of education in kindergarten, which is playing while learning and learning while playing (Dikdasmen, 2009). To support the process of learning reading with the BMTM method, learning media is used. The media that can be used for learning reading with BMTM method is a reading book and the syllables cards.

Along with the increasing number of children who use mobile devices (Rende, 2013), many developed applications of mobile devices can be used as learning media, such as applications for learning mathematics, reading and others. Based on a study, the mathematics application of the mobile device used as a learning media can improve student achievement (Zhang, Trussell, Gallegos, & Asam, 2015).

Google Play is an Android market providing applications for mobile devices with an Android operating system. These applications can be downloaded from Google Play, either free or paid. One of them is an application for learning reading which applies the BMTM method (Google Play, 2015). The application can be downloaded for free at Google Play. So in addition to the reading books and syllables cards, applications on mobile devices can also be used as a media for learning reading, but the application still has a weakness because users can only learn the symbols and sounds of syllables (Google Play, 2015). There is no game page containing elements of the game accordingly with Prensky (2001), i.e. the rules, goals and objectives, outcomes and feedback, conflict/competition/challenge/opponent, interactions and representations on the application. This makes the application less entertaining and less interesting. Therefore, it is necessary to develop an android application for learning reading that is more interesting.

Android educational game can become an alternative for developing a learning reading media because the educational game is created not only for learning but also entertaining (E-learning Faculty Modules, 2012). According to some researchers, educational games used as learning media, can increase learning motivation, and also can improve student achievement (Chu & Chang, 2014; Hwang, Sung, Hung, Huang, & Tsai, 2012; Kordaki, 2011). Later studies conducted by Hung, Huang, and Hwang (2014), state that the achievement of students who learn using games on mobile devices is higher compared with students who use e-book applications in learning. Other studies on mobile learning indicated that using mobile phones for vocabulary learning is more effective than using traditional vocabulary learning tools (Basoglu & Akdemir, 2010).

Based on the abovementioned description, this research aimed at designing and developing a new android educational game that applied the *BMTM* method. The developed android educational game hopefully can be an effective tool for learning reading.

Overview *BMTM* Method and Android Educational Game

BMTM Method

Inventor of *BMTM* method is Intan Noviana. In her book, Intan Noviana mentions that reading ability is necessary for children, especially for children who will continue study to elementary school. In this method for learning reading, children are not taught reading, but invited to participate in playing, drawing, or other activity that they like. In this method, children are not directly introduced to the letters, because making them memorize the letters can burden the children's mind (Noviana, 2013).

After children know some of the syllables, they are given a few words to read. If the children can read these words, they were given awards, for example with praise or with other positive things that can make them happy and feel valued. It can make children more enthusiastic to learn reading (Noviana, 2009).

The advantages of *BMTM* method, for example (Noviana, 2008) are:

a. Children are active, meaning that only by giving a sample for reading the children can learn to read independently.

b. Teachers can implement assistance system, with aid from other students with better reading ability.

c. By having a *BMTM* book, children can learn in school, and also in the home with the parent's aid.

In practice book for reading with *BMTM* methods, children learn some syllables and many words. Syllables introduced in this book are (Noviana, 2008): a, ba, ca, da, ka, la, ma, na, sa, ja, ra, pa, i, bi, ci, di, ki, li, mi, ni, si, ji, ri, pi, u, bu, cu, du, ku, lu, mu, nu, su, ju, ru, pu, o, bo, co, do, ko, lo, mo, no, so, jo, ro, po, e, be, ce, de, ke, le, me, ne, se, je, re, pe, ta, wa, ga, ha, ya, fa, nga, nya, va, za, ti, wi, gi, hi, yi, fi, ngi, nyi, vi, zi, tu, wu, gu, hu, yu fu, ngu, nyu, vu, zu, to, wo, go, ho, yo, fo, ngo, nyo, vo, zo, te, we, ge, he, ye, ve, nge, nye, ve, ze, da-n, me-m, be-r, ku-s, ya-ng, wa-h, sa-l, ga-p, ra-f, sa-w, pa-k, ma-t, ka-v, ta-b, ma-g, ra-y, ta-j, ko-ny, kha, pro, sya, qu, tri, dwi, kra.

Android Educational Game

An educational game is a game designed to teach humans about a specific subject and to teach them a skill (Keesee, 2012). Educational game is designed for learning and for entertaining (E-learning Faculty Modules, 2012). The educational game can maintain student motivation, and also can lead them to learn on their own, without requesting (Brawerman, Bortoloti, Guimaraes, Granato, Aroldi, & de Sauza, 2013). According to Prensky, games are a subset of play and fun; there are six structural elements of games, that are rules, goals or objectives, outcomes or feedback, conflict/ competition/challenge, interaction, and representation or story (Prensky, 2001).

The Android is an operating system for mobile devices such as smartphones and tablet computers (Begin Android, n.d.). So, the android educational game is a game designed to support the teaching and learning that run on mobile devices with an Android operating system.

Some research about the effectiveness of using computer game in learning has been done. To improve the effectiveness of computer game, some research developed computer games that apply important concepts in learning. Socio-cultural and constructive approach, as well as the principles of computer game design applied in computer card game, the game result is a positive effect on motivation and learning for students to learn the concept of binary numbers (Kordaki, 2011). The concept of learning styles applied in a natural sciences game, can increase motivation and student achievement (Hwang, Sung, Hung, Huang, & Tsai, 2012); the concept of two-tier test that applied in a natural sciences game was also effectively used in learning (Chu & Chang, 2014). Some researchers have developed educational games for mobile devices, for example, a math game. Educational game that was developed as a learning mathematics media effectively improved learning motivation and achievement in primary school pupils (Hung, Huang, & Hwang, 2014). Additional research is about developing android games for learning reading (Brawerman, Bortoloti, Guimaraes, Granato, Aroldi, & de Sauza, 2013), but this game does not apply the *BMTM* method.

Basic Principles of Two-Dimensional Graphics

This theoretical review is adopted from Klawonn (2012). The objects made in this educational game is the two-dimensional graphics. The basic geometric objects in computer graphics are points, straight and curved lines and areas as well as character strings. Point are uniquely by their x- and y- coordinates. Lines, polylines or curves an be defined by two or more points. Areas are usually bounded by closed polylines or polygons. In addition to geometric objects, geometric transformations play a crucial role in computer graphics. The most important geometric transformations are scaling, rotation, shearing, and translation.

A scaling leads to stretching or shrinking of objects in the direction of the x- and y-axis. A scaling S(Sx,Sy) maps to the point (x,y) to the point (x',y') given by

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} Sx \cdot x \\ Sy \cdot y \end{pmatrix} = \begin{pmatrix} Sx & 0 \\ 0 & Sy \end{pmatrix} \cdot \begin{pmatrix} x \\ y \end{pmatrix} \qquad \qquad \text{.... (1)}$$

The rotation is carried out anticlockwise around the origin of the coordinate system in case of a positive angle. A negative angle means that the rotation is carried out in a clockwise manner. The rotation

R(θ) by the angle θ maps the point (x, y) to the point (x',y') given by

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} x \cdot \cos(\theta) - y \cdot \sin(\theta) \\ x \cdot \sin(\theta) + y \cdot \cos(\theta) \end{pmatrix} = \begin{pmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{pmatrix} \cdot \begin{pmatrix} x \\ y \end{pmatrix} \quad \text{....(2)}$$

A shearing requires two parameters, however, not on the main diagonal of transformation matrix, but on the other two positions. Applying a shear transformation S (Sx,Sy) to a point (x,y) yiels the point (x',y') with the new coordinates

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} x + Sx \cdot y \\ y + Sy \cdot x \end{pmatrix} = \begin{pmatrix} 1 & Sx \\ Sy & 1 \end{pmatrix} \cdot \begin{pmatrix} x \\ y \end{pmatrix} \quad \text{....(3)}$$

A translation T(dx, dy) causes a shift by vector d = (dx, dy)^{T}. This means the translation maps the point (x, y) to the point

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} x + dx \\ y + dy \end{pmatrix} = \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} dx \\ dy \end{pmatrix} \quad \text{....(4)}$$

Development android educational game for learning reading

UML (Unified Modeling Language) Design

Activity Diagram

Figure 1 describe the Activity diagram of android educational games. Activity diagram of an android educational game is designed with the book reference from Fowler (2003). When the user first opens an android educational game, the user can select one of 5 main menu options, namely start game, help, about, score history, and exit.
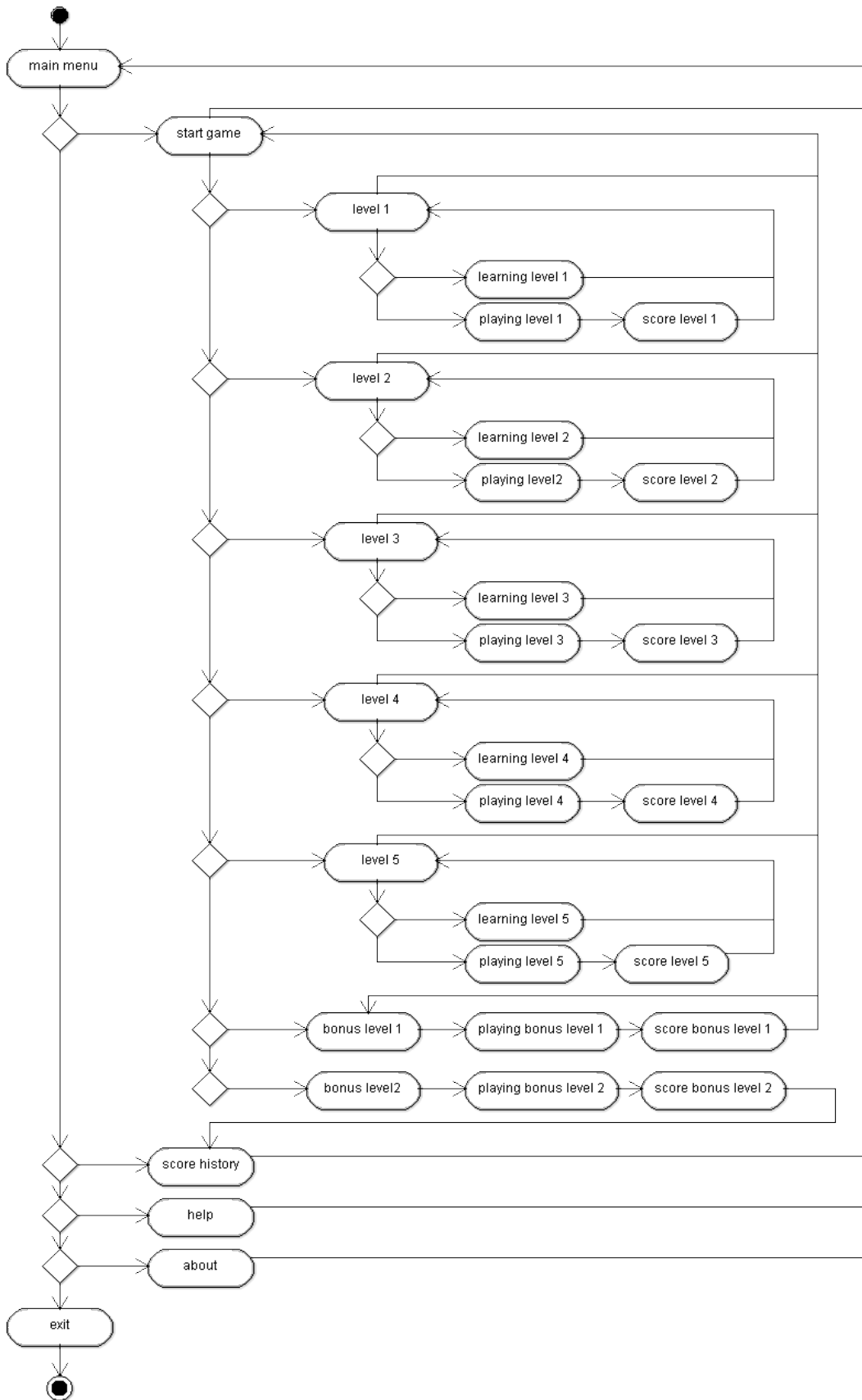
Fig 1. Activity Diagram for Android Educational Games.

When user chooses start game, user can open level 1 to level 5, and also bonus level 1 and 2. In each level user can choose the learning and playing menu. In playing page user must play the game in order to get a score. User must obtain score >= 4, beforehe or she can continue play to the next level, until finished. If the score has not reached 4, the user must repeat playing in this level. Obtaining a score of each level will be displayed on the score history page. Score history page only displays the saved last score obtained by the user.

Interface, Animation and Narrative or Audio Design

This section describes interface design, animation design, and narrative or audio design. Interface design, animation design, and narrative or audio design of android educational game such as at Playing page design, is:

Interface design
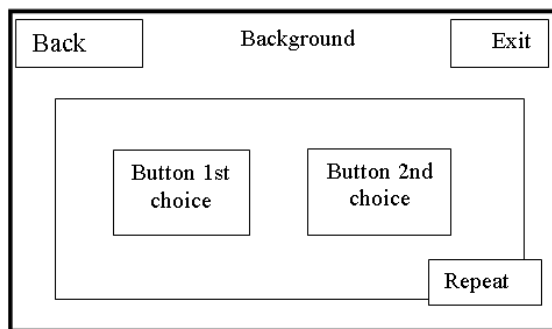
Fig 2. Interface Design of Playing Page

The interface design of playing page is described in Figure 2. The page contains 5 buttons. The button back is for going back to previous page, button exit for exit the game, button repeat for repeat the question, and 2 buttons for answer choice.

Animation design

The animation is shown for the correct answer. If the answer chosene is correct, button answer will be enlarged with the scale (Sx,Sy) = (1, 5 ; 1, 5). Start point coordinate of the button answer is:

(x1,y1) = (0,0)

(x2,y2) = (200,0)

(x3,y3) = (200,150)

(x4,y4) = (0,150)

Based on formula scaling (2) resulting new point coordinate of the button correct answer:

(x1',y1') = ((0*0)+(0*(1,5)), (0*0)+(0*(1,50)))

= (0,0)

(x2',y2') = ((0*0)+(200*(1,5)), (0*0)+(0*(1,5)))

= (300,0)

(x3',y3') = ((0*0)+(200*(1,5), (0*0)+(150*(1,5)))

         = (300,225)

(x4',y4') = ((0*0)+(0*(1,5), (0*0)+(150*(1,5)))

          = (0,225)

Narrative or audio design

The narrative or audio that given in this page is:

- Voice of the question.

- Voice *benar* if the answer is correct.

- Voice *oops* if the answer is wrong.

Software and Hardware Requirements

Software Requirements

Software used in producing of educational game are as follows:

1. Windows 8 Pro as an operating system

2. Adobe Flash Professional CS6 for making games

3. CorelDRAW X6 to create an image object

4. Android Kitkat 4.4.2 as a mobile operating system

Hardware Requirements

Hardware specifications used in producing educational games are as follows:

1. Processor: Intel (R) Celeron (R) CPU GHz N2840 2:16

2. RAM: 2 GB DDR3 L Memory

3. Hard Drive: 500 GB

4. Monitor, Keyboard, Mouse

5. Galaxy tab 3 8.0

ActionScript

Script that be used in game development is ActionScript3. Some ActionScript created in some sections are as follows:

1. ActionScript to open start game menu

mulai.addEventListener(MouseEvent.CLICK,start1);

```
function start1(event:MouseEvent):void

{ orang_1.gotoAndPlay(2);

  mov_judul.visible=false;

  mulai.visible=false;

  buttona.visible=false;  }
```

2. ActionScript to create a score storage

```
var skor_game1 :SharedObject = SharedObject.getLocal("skor_gamel");

var skor_game2 :SharedObject = SharedObject.getLocal("skor_game2");

var skor_game3 :SharedObject = SharedObject.getLocal("skor_game3");

var skor_game4 :SharedObject = SharedObject.getLocal("skor_game4");

var skor_game5 :SharedObject = SharedObject.getLocal("skor_game5");

var skor_game6 :SharedObject = SharedObject.getLocal("skor_bonusl");

var skor_game7 :SharedObject = SharedObject.getLocal("skor_bonus2");
```

3. ActionScript to move next question and increase score in playing page

```
MovieClip(this.parent).nextFrame();

MovieClip(this.parent.parent).posisi++;

MovieClip(this.root).bintang++;

MovieClip(this.root).skor_game1.data.count=MovieClip(this.root).bintang;
```

Implementation of educational game development

Android educational game created using Adobe Flash Professional CS6 software. The steps of created educational game are make a 2D object, make animation or audio on object, and add script on the object.

The first step was to make 2D objects accordingly with the interface design. After that, create the animations for these objects accordingly with the animation design which has been made before. The animations used a transformation. The transformations consist of translation, rotation or scale. To determine the position of the object (x, y) and size of the object that created in this game, was set on the position and size panel. Last, the ActionScript was added on the objects that need a script.

Result of developed android educational game for learning reading

The Android educational game for learning reading is an educational game created specifically for smartphones or tablets with an Android operating system that applies the *BMTM* method. This educational game is a 2D game because the objects in this game are the 2D objects. This educational game introduces 60 syllables: a, ba, ca, da, ka, la, ma, na, sa, ja, ra, pa, i, bi, ci, di, ki, li, mi, ni, si , ji, ri, pi, u, bu, cu, du, ku, lu, mu, nu, su, ju, ru, pu, o, bo, co, do, ko, lo, mo, no, so, jo , ro, po, e, be, ce, de, to, le, me, ne, se, je, re, pe.

The developed educational game contains the structural elements of games, namely the rules, objectives, outcomes and feedback, conflict/competition/challenge/opponent, interactions and representations.

Educational game was created with the adventure model, which consists of 7 levels namely level 1, level 2, level 3, level 4 and level 5, and 2 bonus levels. Figure 6, 7, 8 and 9 display the appearance level 1 of guess word game. The mission of this adventure is to open the whole key by answering questions at each level. At the beginning of the game the whole key level will be locked, but the key on level 1 is opened. At each level there is a choice of two buttons (play button and learn button). Learn button is used to access the learning page, while the play button is used to access the playing page. On the learning page 12 symbols of syllables and sound of the syllables are introduced. At level 1 the child learns syllables: a, ba, ca, da, ka, la, ma, na, sa, ja, ra, pa. Level 2 kids learn syllables: i, bi, ci, di, ki, li, mi, ni, si, ji, ri, pi. Level 3 children learn syllables: u, bu, cu, du, ku, lu, mu, nu, su, ju, ru, pu. Level 4 children learn syllables: o, bo, co, do, ko, lo, mo, no, so, jo, ro, po. While level 5 children learn syllables: e, be, ce, de, to, le, me, ne, se, je, re, pe.

While on the playing page the children were given 10 questions. There is a sound of the question; the child must listen carefully and then choose the correct word. But children can repeat the question by choosing the button repeat. Children must answer a minimum of 8 questions correctly to get a 4 star and can unlock the next level. If the children answered all the questions correctly, they will obtain 5 stars. If the children have not managed to answer the questions and get less than 4 stars, the key to the next level cannot open, so they must repeat the game.

Fig 6. Question in level 1

Fig 7. The Correct answer

Fig 8. Feedback for the Correct Answer

Fig 9. Feedback for the Wrong Answer

If the children can answer the questions correctly, the word will be scaled bigger, and then it would display the smile expression and sound "*pintar*" (smart), while if the answer is wrong it will display the sad expression and sound "ups". It is as feedback that children get.

In the bonus levels there is only a playing page. In this level there are 10 questions. Children must sort the syllables correctly. They can shift syllables one by one and sort them in the box provided. The words of three syllables are used in these levels.

In this game there is also a help page that can help the player. Before the game is used directly by the children, it would be good for the teacher or parent to understand the instructions, so that they can explain it to the children.

EXPERIMENT DEVELOPED ANDROID EDUCATIONAL GAME FOR LEARNING READING

Design evaluation experiment

The experimental sample consisted of 26 children in Mutiara Hati Kindergarten. Mutiara Hati Kindergarten was chosen as the experimental sample because the kindergarten's students have less reading ability. Students will be divided into two groups: 13 students in the experimental group and other students in the control group. The experimental group used an android educational game on tablet or smartphone as a learning medium, while the control group used reading book as learning medium. Each group was taught by one teacher in kindergarten.

The research instrument used was the pre-test and post-test sheets. Pre-test sheet was used to measure student's reading ability before the treatment. Pre-test sheet consists of 40 words that must be read by the students. Total score for the pre-test is 40. The post-test was used to measure student's

reading ability after receiving treatment; the questions were the same with the pre-test, the difference is that the words that should be read by students were randomized. The correct answer gets 1 score, while the wrong answer will get 0 score.

Students were divided into an experimental group and a control group. After being divided into two groups, each group will get a pre-test. The pre-test was conducted by kindergarten teachers together with the observer. In the pre-test, students were tested one by one to read the words written in the pre-test sheet. After the pre-test, the experimental group will use an android educational game on a tablet or smartphone media in the learning process, while the control group will use the reading book in the learning process. Each group will be taught by one teacher. Before starting the learning process, teachers in the experimental group were given training on how to use the android educational game.

After the learning process for approximately 240 minutes, the students get a post-test; post-test implementation is equal to the pre-test, where students are tested one by one to read the words written in the post-test sheet. The results of pre-test and post-test in the experimental group and the control group will be analyzed with quantitative analysis. The flow diagram of the experiment design is shown in Figure 10. The flow diagram is modified from Hwang et al. (2012).
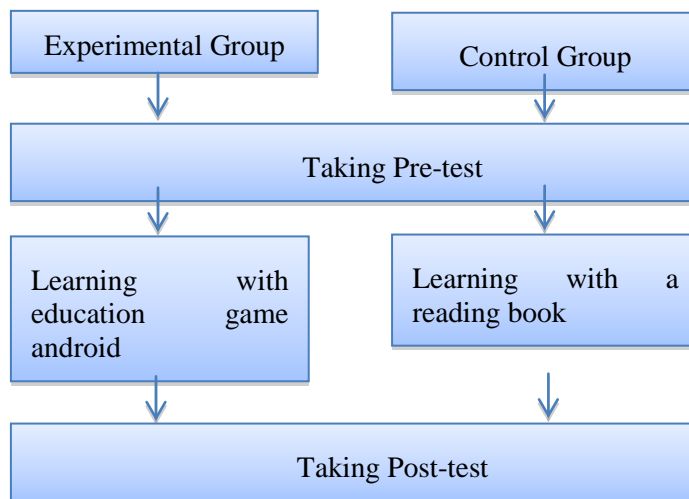
```
┌─────────────────────┐        ┌─────────────────────┐
│ Experimental Group  │        │    Control Group    │
└──────────┬──────────┘        └──────────┬──────────┘
           ↓                              ↓
┌──────────────────────────────────────────────────┐
│                 Taking Pre-test                    │
└──────────┬──────────────────────────┬─────────────┘
           ↓                          ↓
┌─────────────────────┐        ┌─────────────────────┐
│ Learning    with    │        │ Learning    with  a │
│ education    game    │        │ reading book        │
│ android              │        │                     │
└──────────┬──────────┘        └──────────┬──────────┘
           ↓                              ↓
┌──────────────────────────────────────────────────┐
│                 Taking Post-test                   │
└──────────────────────────────────────────────────┘
```

Fig 10. The Procedure of experimental diagram

Experiment result and discussion

Data analysis was conducted to analyze the differences in reading ability between the experimental group and the control group, and also to determine how much influence the use of android educational game had on the experimental group. The result of pre-test for experimental group and the control group is shown in Table 1. While the graph of pre-test mean and post-test mean between the experimental group and the control group is shown in Figure 11.

Table 1. Results of Pre-test and post-test experimental group and the control group

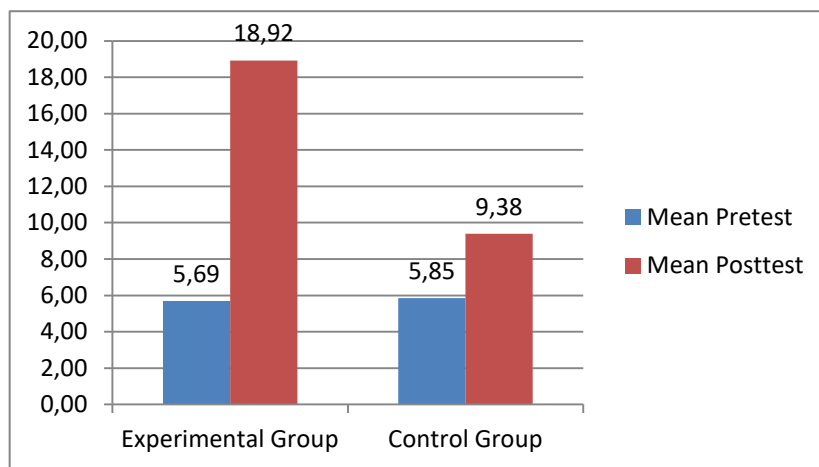| Experimental Group			Control Group		
Student's Code	Pretest Score	Posttest Score	Student's Code	Pretest Score	Posttest Score
E-01	0	15	C-01	7	10
E-02	1	16	C-02	21	30
E-03	16	33	C-03	4	6
E-04	1	6	C-04	0	1
E-05	0	14	C-05	0	1
E-06	0	10	C-06	0	2
E-07	0	20	C-07	5	7
E-08	0	5	C-08	1	5
E-09	0	1	C-09	18	28
E-10	3	18	C-10	3	4
E-11	9	39	C-11	0	1
E-12	6	29	C-12	17	21
E-13	38	40	C-13	0	6
Sum	74	246		76	122
Mean	5.69	18.92		5.85	9.38

Fig 11. Graph of pre-test mean and post-test mean of the experimental group and the control group

From Figure 11 it can be seen that the pre-test mean of the experimental group is slightly lower than for the control group; the experimental group had pre-test mean score 5.69, while the control group had pre-test mean score 5.85. However, the post-test mean of the experimental group was higher than for the control group; the experimental group had post-test mean score 18.92, while the control group had post-test mean score 9.38. Based on the experimental result, the increase in the pre-test mean and post-test mean between the experimental and the control group can be calculated. Increase in the mean score of the experimental group was calculated from the difference between the mean scores of post-test minus the mean pre-test score was 13.23. While the increase in the mean score of the control group, calculated from the difference between the mean scores of post-test minus the mean pre-test score was 3.54. When compared, the difference of mean score of the experimental group was higher than for the control group.

To determine the improvement of student reading ability in the experimental group, an analysis was conducted on the results of the pre-test and post-test. Analysis used is the formula average normalized gain (g) is as follows (Hake, 1998):

$$(g) = \frac{(\%G)}{(\%G)max}$$

$$(g) = \frac{[(\%posttest) - (\%pretest)]}{[(100\%) - (\%pretest)]}$$

$$= \frac{18.92 - 5.69}{40.00 - 5.69}$$

$$= 0.39$$

The result of gain score of student's reading ability in the experimental group, an increased by 0.39 is located at 0.3 ≤ g ≤ 0.7; hence the result is in medium category.

CONCLUSIONS

The research and development resulted in the new android educational game for learning reading. The educational game applied the BMTM method and it contains the structural elements of games, namely the rules, objectives, outcomes and feedback, conflict/competition/challenge/opponent, interactions and representations. The developed educational game was evaluated with the evaluation experiment. There are two groups in this evaluation, that is experimental group which used the android educational game, and the control group which used a reading book. The results of the evaluation experiment showed an increase in post-test scores in both groups. However, the experimental group had a higher post-test score mean than the control group. The experimental group had a post-test score of 18.92, while the control group had a post-test score of 9.38. The experimental group gain score increased by 0.39, an increase in the medium category. From the experimental results, it can be concluded that developed android educational games can improve students' reading ability in the medium category. Thus, the android educational game can be used as an alternative tool for learning reading which is better than a book. For further research it is suggested to develop an android educational game using all syllables in BMTM method for learning reading.

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