

# The Implementation of A Star Algorithm (A\*) In the Game Education About Numbers Introduction

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**Abstractt-The concept of number introduction is a basic learning for preschool. Playing while learning is the right method to be applied in introducing the concept of numbers for children, considering that preschool is a time when they play and get to know the environment. Educational games are one of the medias that can be used to support learning activity in today's digital era. Developing of this game, contains a concept of number introduction with adventure genres on the Android platform by applying the A\* algorithm. Algorithm A\* is one of searching algorithm to find the shortest route with the minimum cost. Through this educational game, parents are also expected to be able to take part in giving motivation and learning support will be more effectively then the closeness of the relationship between parents and children is also built.**

**Keywords - algorithm A\*; android; educational games; introduction to numbers; preschool;**

## I. INTRODUCTION

Today, preschool is one of the trends in our society because as we know that there are so many institutions of education is preschool. It is undeniable, the age of children under 5 years is a golden age. According to Uce (2017), the various studies show that the Golden Age is a very effective and urgent time for the optimization of various potential intelligence possessed by children towards quality human resources. Stimulus of preschool learning from the surrounding environment as well as learning while playing. Too early age, requires educators to deliver learning in a simple language but more effective, interesting and easy to understand. [1]

Educational games can be a solution to these problems, besides having an interest visualization, it is also equipped with sounds to animations that are liked by children. Educational games also make it easier for educators to deliver a learning concept. Besides that, through a game at least parents can also take part in giving motivation and learning support to be more effective. One lesson that can be applied to an educational game is mathematics. The introduction of mathematics for children begins with the concept of number introduction, starting from the form of numbers, the mention of numbers and the introduction of counting slowly with media objects, pictures or games. One indicator of the basic development in the preschool syllabus is to say by showing the concept of numbers (numbers or concepts of numbers with objects), the media that usually

used is still limited to printed media such as magazines or whiteboard media. And we know that, every child didn't have the same ability, so that children with low cognitive abilities will of course be left behind.

This game, contains a concept of number introduction with adventure genres on the Android platform. This educational game is carried out by individuals so that indirectly the explanation of the concept of number recognition becomes more effective in helping teaching and learning activities.

## II. THEORY

### A. A\* (A Star) Algorithm

In 1968, an algorithm A\* (A Star) was first discovered by Peter Hart, Nils Nilsson and Bertram Raphael. According to Aslami (2015), the A Star algorithm is a graph searching algorithm that finds paths from the initial status and final status. Algorithm A\* needs two lines, that called OPEN and CLOSED. OPEN contains nodes that still have the opportunity to be selected as the best node, while CLOSED contains nodes that cannot be selected as the best node (opportunities for selection are closed). This algorithm uses heuristic functions (usually denoted by  $f(n)$ ) to determine the sequence, where the search is done by visiting nodes in the tree.  $f(n)$  represents the cost of the most efficient way to the destination. The notation of the method is in accordance with Equation 3. [2]

$$G(n) = G \text{ node} + 10(\text{straight}) \text{ atau } 14(\text{sideways}) \dots \dots \dots \text{Equation (1)}$$

$$H(n) = |X(\text{target}) - X(n)| + |Y(\text{target}) - Y(n)| \dots \dots \dots \text{Equation (2)}$$

$$F(n) = G(n) + H(n) \dots \dots \dots \text{Equation (3)}$$

Information:

- F(n) = Addition of distance of Gn and Hn
- G(n) = Distance between the node and the initial node
- H(n) = Distance between the node and the aim node

### B. Educational Games

Games that have educational content are better known as educational games. This educational game aims to attract students' interest in learning the subject matter in a fun way, and with this feeling of joy it is expected that they can more easily understand the subject matter that presented.

According to Novaliendry (2013: 112) educational game is a game that is specifically designed to teach the user associated a certain learning, concept development and understanding and guide them in their ability to train and motivate them to play it. In this era, there is often the term Game- Based Learning (GBL). Game-based Learning is a term for educational games about computer applications or that there is a game console. [3]

Based on the description above, it can be concluded that the educational game is one form of game that can be useful to support the teaching-learning process in a more fun and creative way, and is used to provide teaching or increase the knowledge of users through an interesting media. According to Prot (2012: 648) the game has negative and positive effects according to the type and how to respond to the game. The positive effect such as: (1) *action games* can increase the skills range of visual spatial (2) *educational games* taught and improve specific skill, (3) *exergames* can increase the level of activity of physic, and (4) *prosocial games* game can improve empathy and helps reduce aggression. [4]

Another benefit according to Tanner & Jones in (Annetta, 2008: 233) games can give a motivation for passive learners to be able to contribute more in teaching and learning activity. Video games motivate their learning activities with curiosity, challenge, fantasy, fun, and social recognition. This kind of thing cannot be given to conventional learning systems. [5]

The same thing was expressed by Park (2012: 103), as a student's personal experience such as curiosity, fantasy, control, challenge, and the desire to compete, which is obtained through playing video games is an experience that is difficult to find in life daily. These experiences help students in the learning process later. [6]

### C. Android

Android is a Linux-based open source operating system designed for mobile devices. Android provides an open platform for developers to create their own applications for use by various mobile devices (Pratama, 2016). So that the operating system inside the smartphone is currently adjusting from the specifications of the low-end class to the high-end, so that the development of the android system is indeed quite sharply increased. Android uses the first letter of the food name as a marker for upgrading the system. Starting from Cupcake Android 1.5 (C), Donuts Android 1.6 (D), Eclair Android 2.0-2.1, Froyo (2.2–2.2.3), Gingerbread (2.3–2.3.7), Honeycomb (3.0–3.2.6), Ice Cream Sandwich (4.0–4.0.4), Jelly Bean (4.1–4.3), KitKat (4.4+), Lollipop (5.0+), Marshmallow (6.0+), Nougat (7.0+) and Android Oreo (8.0 +), and the latest is Android Pie (9.0+). [7]

## III. RESEARCH METHODS

### A. Data Collection

Data collection is the process of collecting various data or information with various techniques in a designed, controlled manner and aims to answer the problem of research (Mukhadis, 2016:309). [8]

The collection of data on this study aims to find out how the development of the game introduction of numbers and

their relationship to education. By knowing empirical data related to games the introduction of the expected number of this study solve the problems of students. To collect data, researchers use two methods, such as:

#### 1. Documentation

Documentation methods is done by looking at the legislation, and circulation letters, journals, papers, books, videos, and other empirical data related to study. At this stage the researcher will know the game development in the education and non-education fields. Hopefully, the research carried out will be better than the previous research. In addition, researchers at this stage will be set materials to be included in the game.

#### 2. Interview

The interview method was carried out after conducting documentation studies. Data from documentation studies were brought to school to find out the actual implementation in schools. At this stage it will be found limitations and general description and specification of the games. So that games are created that are not only in accordance with the theory but can also be implemented in education in real terms.

### B. Analisis Pembangunan Aplikasi *Game* Pengenalan Angka

In this section we will describe the picture, plot, mission, gameplay, and the target of the number introduction game.

#### 1. Introduction to *Game*

This game called number introduction game. This game is a combination of games adventure and learning. Learning is done by introducing numbers from 0-9 for children. Learners can deepen their understanding by entering the stage of adventure. On the stage of adventure, students will be instructed to look for the numbers they have learned. There are enemies who chase players at this stage, which when they are caught by that enemy, the game will end. Game made on the android platform with 2D animation so that children can easily play it.

#### 2. Game Flow

The flow created in this *game* is as follows:

- a. There are number introduction options that they can learn.
- b. Players will be introduced to these numbers with a teacher's video / animation.
- c. If students know the number, they can enter the adventure *stage*.
- d. If students want to repeat the explanation then press the reset button.
- e. At the *stage of* adventure students are expected to move the ball through the path to the numbers learned.
- f. If students can collect all the numbers then it is declared successful.
- g. If students fail to get everything numbers because they are caught by an enemy or run out of time there will be a choice to repeat or learn another.

#### 3. Game Mission

The mission of this game is to get to know the numbers and obtain the highest value in the adventure stage. Introduction of game did not have value because at this stage

learners acquire basic concepts about the numbers they want to learn. On stage adventure students will get a mission to collect the numbers they previously learned. There are enemies who chase and will make the player fail if caught. Besides that, there is a time limit that will make the player fail if the time runs out before the player can collect all the numbers.

4. Determine *Gameplay*

The following are the interactions and rules that can be done in the game:

- a. There is a main menu containing material menu, about us, and exit.
- b. In the material menu players will choose again about the numbers they want to learn.
- c. After selecting a number, it will enter the introduction menu. In this menu there will be an explanation of the numbers they learned from a teacher / animation.
- d. After completing learning, new players can enter the adventure menu.
- e. On a more adventurous menu n the player is asked to move the ball with drag and drop toward each number there.
- f. Each number contains points that will be added up at the end of the game.
- g. There are enemies who chase players and will make them fail if they are caught by the enemy.
- h. There is a predetermined time limit.
- i. The final point is a calculation of the number points and time spent.
- j. The adventure menu can also be accessed directly when they have done previous learning.
- k. The menu about the maker contains data about the maker of numbers introduction game.
- l. The exit menu functions to remove players from the game.

5. Target Users and Use of Game Applications

The stage of preschool is an important stage in human development. One of the things taught in preschool is the introduction of numbers. But not all students can fully understand the teacher's explanation. For this reason, it is necessary to make a learning media that can help teachers in the learning process. One of the learning media that can be used is games. It is expected that the development of this game can help the learning of preschool in the classroom and outside the classroom.

C. Analysis of Algorithms A \*

Algorithms in a game is one of the critical success factors. The algorithm will determine whether the game goes according to expectations or not. Therefore, the use of the right algorithm will increase the percentage of success in making games. Algorithms that have complete and optimal search results are A \* (A star). By applying the A \* at the introduction of the numbers game is expected to solve the problem in the game is complete and optimal. With the results of the calculation as follows:

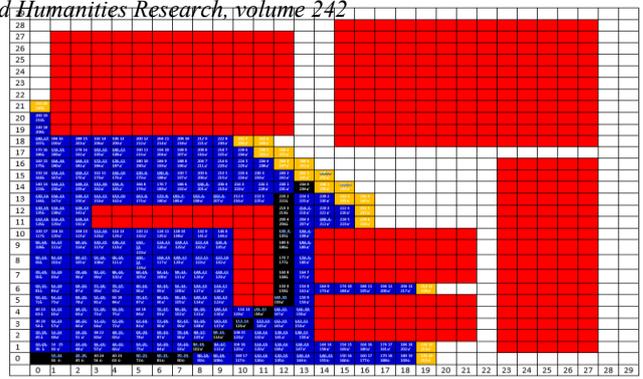


Figure 1 Calculation Results

D. Design of Use Case Diagrams

Use care diagrams are used to draw the overall game framework. The use of use cases is expected to be able to describe what interactions we can do with number introduction games.

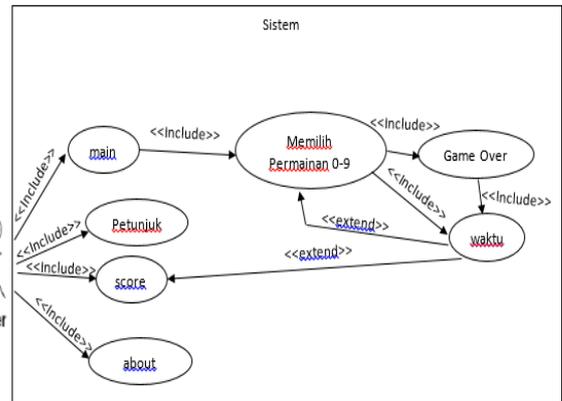


Figure 2 Use Case Diagram Design

E. Pseudocode Design

Pseudocode used to draw algorithm of game. Use pseudocode expected to be able to describe how the A \* algorithm runs on the program.

```

OPEN //the set of nodes to be evaluated
CLOSED //the set of nodes already evaluated
add the start node to OPEN

loop
  current = node in OPEN with the lowest f_cost
  remove current from OPEN
  add current to CLOSED

  if current is the target node //path has been found
    return

  foreach neighbour of the current node
    if neighbour is not traversable or neighbour is in CLOSED
      skip to the next neighbour

  if new path to neighbour is shorter OR neighbour is not in OPEN
    set f_cost of neighbour
    set parent of neighbour to current
    if neighbour is not in OPEN
      add neighbour to OPEN
  
```

Figure 3 Pseudocode

F. Testing Scenarios

Game testing aims to see the success of the game that has been made. The success here does not only mean that the game runs without error but also the success of players who use this game. To be able to know the success of the games, black box testing method is used. By this test

method, researchers are expected to know the success of the game and the things that need to be evaluated.

#### IV. RESULT AND DISCUSSION

##### A. Hardware Implementation

The hardware or device used to run the number introduction game application did not need high specifications. Minimum specifications that can be used to run game applications the introduction of numbers is as follows:

- 1) ARMv7 CPU with NEON support or Atom CPU;
- 2) Graphic Processing Unit Open GL ES 2.0 or above.

##### B. Software Implementation

The software used to run this game must meet the specifications of an Android -based device OS with version 4.1 (Ice Cream Sandwich) or version above.

##### C. Interface Implementation

Use of various color variations, shape, as well as supporting graphics are expected to stimulate cognitive and provide the attraction of children to play while learning. Examples of the display of the main menu design are shown in Figure 4



Figure 4 Main Menu

Game content is designed simply so that it is easier for children to play it themselves. This content is also equipped with interesting visualization, so that children are not bored to play it. The approach to this educational game allows it to be accessed through a platform Android which is currently owned by almost all levels of society. So it's easy to apply either through a cellphone or tablet computer.

##### D. Algorithms A \* (A Star) Testing

This is an application testing algorithm A \* (A Star) to test the software built already running as expected or not yet. Tests are carried out based on algorithm A \* (A Star) on the game menu in the game. The test is assisted by using the web <https://cloud.testdroid.com> to check the portability, RAM, CPU on devices that use this application.

On Figure 5, the location of enemy and player are in the same coordinates in the calculation for example. The shortest node passed by the game is the same as the node in the calculation. With the number of nodes open is 16 and node closed is 232. Then it can be concluded that the algorithm A\* can be applied well to the game.

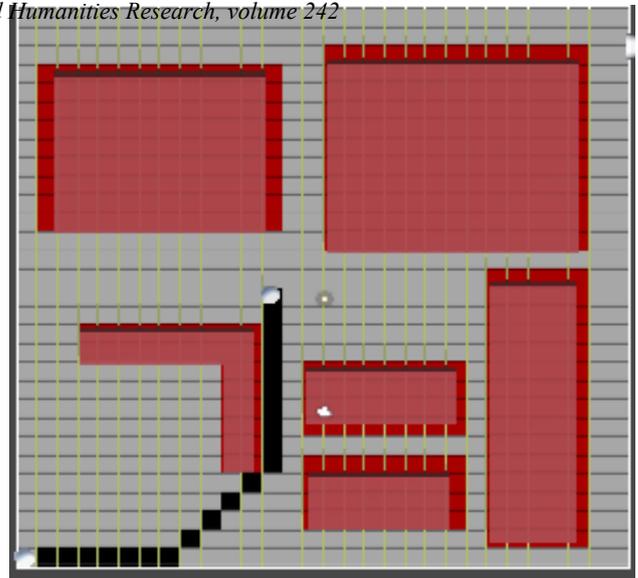


Figure 5 Game Content Design

In this aspect, the method used is by using experiments on several smartphones with Android operating system version of Jelly Bean, Kitkat, Lolipop, Marshmallow, and Nougat to see what the game education application can be installed and executed (table 1).

No	Jenis Perangkat	Jenis Android	Proses Instalasi	Proses Running Game
1	Evercross A80A	4.2.2 (Jelly Bean )	Berhasil	Berjalan tanpa ada error
2	Asus Zenfone 5	4.4 (Kitkat)	Berhasil	Berjalan tanpa ada error
3	LG G3	5.0 (Lolipop)	Berhasil	Berjalan tanpa ada error
4	Samsung J5 Prime	6.0 (Marshmallow)	Berhasil	Berjalan tanpa ada error
5	Xiaomi MI 4C	7.0 (Nougat)	Berhasil	Berjalan tanpa ada error

Table 1 Portability

Based on Figure 6, memory usage by application it is quite safe and this application does not experience lack of memory which causes memory lack which can cause the application to stop.

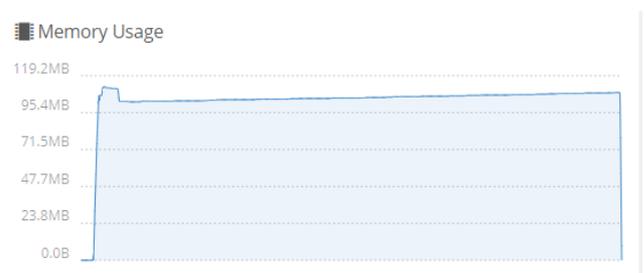


Figure 6 RAM usage

Based on Figure 7, average CPU usage under 25 %. This number is still in under the safe limit smartphones usage.

CPU Usage

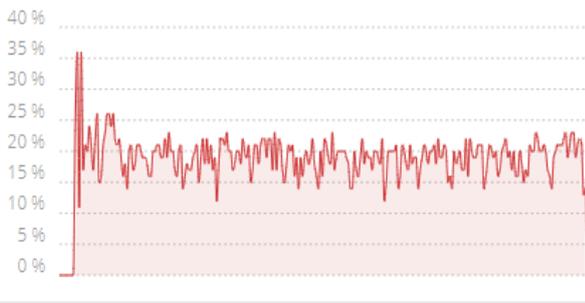


Figure 7 CPU usage

Then, if we want to testing using computer with specifivation like CPE (4 CPUs) 3.1GHz, Memory 8192 MB RAM, and Unity 2018.2.19f1 (64-bit)

No	Koordinat	CPU	RAM	Time	Status
1	(0,0) - (13,13)	5.2%	105.0 KB	10.39 ms	Complete
2	(29,0) - (13,13)	2.7%	105.8 KB	10.91 ms	Complete
3	(0,29) - (13,13)	1.9%	83.5 KB	7.38 ms	Complete
4	(29,29) - (13,13)	1.9%	92.8 KB	8.06 ms	Complete
5	(29,0) - (0,29)	7.7%	213.3 KB	33.88 ms	Complete
6	(0,13) - (29,16)	10.9%	181.4 KB	22.87 ms	Complete
7	(0,0) - (29,29)	9.3%	214.1 KB	31.94 ms	Complete
8	(25,16) - (0,29)	9.2%	205.4 KB	30.84 ms	Complete
9	(0,15) - (29,29)	7.1%	209.3 KB	29.39 ms	Complete
10	(12,0) - (13,29)	6.4%	167.2 KB	19.87 ms	Complete

Table 2. 10 Coordinats experiments

E. Discussion

This study succeeded in developing an educational game through the application of an Android based A \* algorithm. This educational game can be used as an alternative learning media for children to help the introduction of the concept of numbers from an early age.

V. CONCLUSION

The results of the development of an Android -based "Introduction to the Numbers Concept" educational game are very potential to be used as interesting and fun learning media. The use of visualization elements is expected to help children to understand the concept of number introduction while playing.

Although overall the development of this educational game has fulfilled the initial target planned, there are still some shortcomings that need to be refined, and developed again. In this regard, some suggestions are needed to improve the game content even better.

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