The counting game uses the fuzzy Tsukamoto method

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Abstract. Learning to count on elementary school students must be trained in how to memorize, many practice questions are done repeatedly. This counting exercise needs to be stimulated so that students have the motivation to learn, this kind of training is mostly done by the teacher to students by giving questions in turns in one class as if the students are in a game playing condition. Counting exercises can be applied in the form of games with applied counting operations learning to train students to count quickly. The approach with attractive application visualization is expected to be able to help the learning of elementary school level students, especially class 1. Tsukamoto Method, in each rule is represented using a fuzzy set, using a monotonous membership function. To be able to determine the value of crisp output or firm results. By using the Unity 3D game engine that is capable of making 2D games, the Fuzzy Tsukamoto method is used to determine the final game score. Tests that have been done show that the results of the questionnaire that game 2d on the functionality aspect get a result of 3.97 on a scale of 5.

1. Introduction
Counting is one of the abilities that must be possessed by every person, ability to count in society or individuals who are not visible. This is a 'functional skill' that everyone must have that requires repeated practice [1,2]. The ability to count well is likely to help life later, numerical intelligence has a correlation with the success of students when they are adults in general [2]. Ability to count can be increased by frequent training [1].

Primary students at the initial level use punishment, problem solving must begin to be sharpened. Related to counting, cleverness in counting is a part of mathematics that is considered important by society in general. Not infrequently this field of science provides a lot of assistance to other related fields of science, specifically in the development of elementary school children. However, many students have difficulty understanding the basics of mathematics so many fail in this field of science, because mathematics often causes high levels of difficulty in students [3].

Primary school teachers often experience many students not having good enough to learn mathematics, and many of these students have the pleasure of lacking in class learning or trying to stay away from learning mathematics. To encourage students' interest in learning mathematics and help students overcome learning difficulties, various innovative supports have been applied to mathematics. Practice learning to count in elementary school is usually done by asking questions to all students in the class in turns. Such a process is carried out repeatedly in the hope that students will be more proficient in counting, so that students are positioned must always be ready to answer when the turn of the question reaches him the same as students playing the game.
The advancement of digital technology makes many ways of learning models that can be done through games. Classroom training in the classroom given by the teacher to students can be replaced in the form of games that can be done on a smartphone, so students can learn to count through game play. So that Android games that can work on smartphones are proposed to be useful to train numeracy reasoning abilities of students and also the ability to think logically [4].

2. Stages of knowing numbers and counting
Little children begin to learn to compile compilation, they can talk and argue, children agree to start what adults say about numbers.

2.1. Knowing numbers
At the beginning of the child learning basic mathematics is taught to recognize numbers, whose purpose is to recognize the concept of numbers, both verbally and in writing. In this step there is a connection with starting to sharpen a child's memory skills. The next step is to sort the numbers, the smallest number towards big. If the child's memory ability is good, then the child will be able to work both verbally and in writing [5]. The concept of numbers is introduced further by teaching the difference between one (1) with number four (4), sorting, and the child must understand the concept of correspondence, that is, one (1) represents one object, and number four (4) represents four objects. Then the child is taught that one (1) is smaller than four (4). So that the child will understand the value of each number and concept fewer and more. Next the child is taught a simple counting operation, by introducing a less concept (-) and adding (+). the above stage cannot be reversed or skipped, because the child will have difficulty performing count operations even though it is simple, the procedure above can be implemented in a digital game [6].

2.2. Counting exercises in the form of games
Improving the ability of students to count, usually the teacher gives questions to each student in the class alternately, sequentially or randomly.

All students must be prepared to accept turn questions from the teacher. This rotating question process can be implemented in the form of digital games [1], where the game is made as if the teacher gives repeated counting questions to students. In this game students are always ready to accept questions and answer questions in the form of digital games [7].

3. Developing counting games
Making this game needs to be prepared assets, in the form of images or audio. Then it is implemented from the coding stage to testing. The order of making the game starts from making the gameplay, namely from the menu and the running of the button leading to another scene or action. After the gameplay is created, then continue to apply the method inside which functions to determine the level and scoring.

3.1. System flow
System flow is made to facilitate design and implementation, where planning and implementation adjusts to the flow of the system. This system flow explains the scenario or the next action carried out by the system, the flow of this system is described in the form of a flow chart as in Figure 1. The game system starts from the main menu where there is a start button, when entering the scene select the level, there are four level options. If the user chooses about or credit it will go to the scene credit and can also return to the main menu by pressing the back button. When it comes to level one flow, which is pictorial quiz. After the user presses the level quiz button pictured, the scene will appear and display a question. When all questions are answered, the user score will appear. Users can choose the game again or not by pressing the retry button. Users can also press the back button to select the next level or return to the main menu.
Figure 1. Main menu flow chart.

Figure 2. Level 1 flow chart.
In Figure 2 the level one flowchart is explained, which is pictorial quiz. After the user presses the level quiz button pictured, the scene will appear and display a question. When all questions are answered, the user score will appear. Users can choose whether to play again or not by pressing the retry button. Users can also press the back button to select a level or return to the main menu. There are still 3 more levels but not illustrated in this paper.

4. Method
The Tsukamoto method, each rule is represented by a fuzzy set, with a monotonous membership function [8]. To determine the value of crisp output or firm result (Z). By changing the input (in a fuzzy set obtained from the composition of fuzzy rules) it becomes a number in the fuzzy set domain.

This method is called the defuzzification method. The defuzzification method used in Tsukamoto is a centralized defuzzification (Center Average Defuzzyfier) [9]. This final result is used to display the score and number of stars that the user gets.

Figure 3. Fuzzy set.

Figure 3 is a set of fuzzy functions that reflect the stages in determining the score. The following are the steps that have been set up such as the formation of fuzzy sets, collection functions and rule settings as in table 1.

| IF   | SPEED (A) | POINT (P) | SCOR (S) |
|------|-----------|-----------|----------|
| R1   | FAST      | LITTLE    | ENOUGH   |
| R2   | FAST      | MEDIUM    | ENOUGH   |
| R3   | FAST      | MANY      | GOOD     |
| R4   | MEDIUM    | LITTLE    | LESS     |
| R5   | MEDIUM    | MEDIUM    | ENOUGH   |
| R6   | MEDIUM    | MANY      | ENOUGH   |
| R7   | SLOW      | LITTLE    | LESS     |
| R8   | SLOW      | MEDIUM    | LESS     |
| R9   | SLOW      | MANY      | ENOUGH   |

5. Results and discussion
Counting games are played on Smartphone devices, so learning to count can be anywhere. The following are the results of the application that has been carried out on an Android smartphone. In figure 4.a is a pictorial problem display, the user runs a count operation with the addition operation. Users play by summing the pictures of the car above with the image of the car underneath and the choice of answers according to the button below, the purpose of the pictorial question is to understand the concept of numbers through images and the results are represented in numbers.
In the number display, users will get the choice of addition, mixture and mix. The purpose of this session is to train users to improve their numeracy skills [10,11], sharpen their memory and practice their motor skills, because the answer choices must be to the location of the answer in figure 4.b [12] and games help teachers in their work evaluate student skills [10].

6. Conclusion
In this paper, "Counting games using the Fuzzy Tsukamoto Method" have the following advantages: (1) counting games can improve numeracy and memorization skills [11], (2) understand the operating functions in calculations, minus operators, and sum operators; (3) Interactions between the user and the smartphone screen can provide motoric training in addition to producing logical thinking during play. (4) From the aspect of functionality, this game gets a result of 3.97 on a scale of 5.

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