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3D modeling and animating of characters in educational game

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Abstract. Bahasa is an identity of the Indonesian nation which grow very fast for the unifying tool of ethnic groups so that it can increase of foreigners' interest in learning Bahasa as a tool to achieve, politics, trade, art and culture, and tourism goals. Many foreigners want to learn Bahasa Indonesia by the following program of BIPA (Bahasa Indonesia untuk Penutur Asing). However, the learning program of BIPA class is still conventional. Games can be used as an alternative educational media for BIPA learning in changing conventional learning methods so that they can visualize real problems. An Android-based game called "Asiknya Berbahasa" is an educational game of BIPA basic level material which has 3 stages; easy, medium and difficult stage and be completed with 3D character models along with the animation. 3D modeling and character animation referring to the Game Development Life Cycle (GDLC) method consists of several stages of initiation, pre-production, production, testing, beta, and release. Testing on 3D models and character animation using a Likert scale shows approval of the average value result test

1. Introduction
In 2017, based on data released by the Indonesian Ministry of Research and Higher Education, study program of BIPA became the top five in the study programs for foreign students because of the great interest of these foreign students to learn Bahasa.

The result of the interview that conducted with BIPA program manager, Leli Dwirika said the learning program of BIPA class is still conventional, using a syllabus or textbook, that are difficult to understand and not easily remembered by foreign students. So that, an interactive and interesting Bahasa learning media is needed to overcome these problems. One of them is educational game-based learning media. In the game, the approach is able to stimulate emotional, intellectual, and psychomotor of a person. "Learning by doing" is easier to remember and comprehend because the material can be understood well [1] According to research conducted [2] using games in the learning can convey the material in a fun way so that it can demonstrate an interactive model.

2. Literature Review

2.1 BIPA
BIPA is Bahasa Indonesia learning media that subjected for a foreign learner. BIPA learning process is more directing students of foreign speakers to be able to master Bahasa Indonesia well and correctly [3]. The level of learning in BIPA can be classified into three levels: beginner level, intermediate level, and advanced level [4].

2.2 Low Poly Modelling
Low poly modeling is a 3-dimensional model technique by using existing basic shapes such as a cube, cone, nurbs, and cylinder. Low poly modeling techniques have a few amount of polygon or modeling
that sacrifices a 3-dimensional model detail with the intention of geometry efficiency that can ease the system workload when designing or during rendering [5].

2.3 Character Game

The types of characters in the game, as below:
1. NPC (Non-Playable Character), is a character in the game that cannot be played by the players. This character has the addition ability of AI or artificial intelligence [6].
2. PC (Playable Character) is a character designation in a game that can be played by the user. This character plays according to the user's orders [6].

2.4 Basic Principles of Animation

There are 12 basic principles of animation [7]:
1. Squash & Stretch is a flexible movement such as objects that are blown away and then stretched.
2. Anticipation is a movement that is performed as a preparation to do the next movement.
3. Staging is the presentation of the overall settings of the scene, camera position or pose of a character so that the scene must be clear and detailed order to be easily understood by the audience.
4. Straight ahead action is an approach to create a continuous movement starting from the beginning without much planning of the movement will be. While Pose to Pose is done by determining the poses first that will be animated in a scene.
5. Follow Through & Overlapping Action is a follow-up movement on the character or object that occurs after the halt of the character or object.
6. Slow In & Slow Out is a slowdown that occurs at the beginning and end of an animation.
7. Arcs are circular curves found in a movement instead of just using straight movements.
8. Secondary Action is an additional movement that occurs to complement the main movements that exist.
9. Timing is determined by the number of frames in between that exist between the movement of an object or character.
10. Exaggeration is an exaggerated movement or expression beyond usual to get a more convincing animation impression.
11. Solid Drawing means an image that has a depth of perspective so that the character looks volume and consistent in each frame of animation.
12. Appeal is the appearance of a character who looks charismatic and interesting to see.

2.5 Education Game

Education or education is a process of changing one's attitude and behavior of a person or group of people to mature humans through teaching and training efforts, processes, ways, and actions to educate [8]. Educational games are games specifically that designed to teach users a particular learning, develop concepts and understandings and guide them in training their abilities, as well as motivating them to play games [9].

2.6 Game Development Life Cycle Method

Game Development Life Cycle (GDLC) is a game development method that has systematic stages in building a game. GDLC method consists of 6 stages as shown in Figure 1 [10].
3. Design And Realization

3.1 Description of Educational Game “Asiknya Berbahasa”

The game "Asiknya Berbahasa" is a single player game that provides challenges for players, quests and tasks also function as story deliver.

Players can control the movement of characters such as going forward, backward, turning right and left in the game to run quests and tasks. The game "Asiknya Berbahasa" has 3 stages that players can go through to reach the final goal of the National Monument. Each stage has different environmental plans and quests and different levels of difficulty, the higher the stage, the more difficult the quest must be for the player.

Based on the Game Development Life Cycle (GDLC) methodology, the initial stage in making games begins with initiation. The results of the concept can be seen in Table 1.

| Game Name               | Asiknya Berbahasa |
|-------------------------|-------------------|
| Game Objective          | To help BIPA students practice Bahasa Indonesia |
| Game Type               | Education and Simulation |
| Characters              | One character is actuated by the player and some NPCs as additional characters. |
| Challenge               | Answering questions and searching for objects. |
| Goal Game               | BIPA Students |
| Game Elements           | Level, Controller dan Scoring |
| Game Model              | 3 Dimensions |
| Game Output             | Android App (.apk) |
| Platform                | Android. |

3.2 Game Design “Asiknya Berbahasa”

3.2.1 Character Design. The characters made must be in accordance with the concepts that have been designed. Figure 2 shows the character and sketching character based on reference.
3.2.2 Storyboard. Storyboard can be made to explain the game workflow in the form of sketches. Table 2 shows storyboard from Stage 1.

| No | Figure | Description |
|----|--------|-------------|
| Stage 1 - Easy Level | | |
| Material: Meet, ask news, directions, price and time. |
| 1 | | At the Easy Level, the position of a character named Justin is in the Gondangdia Train Station building. Characters should talk and look for someone to get directions. |
| 2 | | Justin walked to a woman named Tika (NPC) who was standing in the station. |
| 3 | | Justin asks directions to go to the National Monument to Tika. Tika answers Justin's question by asking him to answer some questions. |
| 4 | | Justin answers some questions that are quests of this level. The existing question is a short question about the beginner level BIPA material that the player must answer. |

3.3 Realization of Game Character Design
This stage begins to create 3D character models, by giving material to characters, rigging and animating characters.

3.3.1 Character Modeling. Making the character model "Asiknya Berbahasa" is using Primitive Modeling techniques. The process uses several modeling techniques such as translation, scale, rotation, mirrors, extrude and loop cut so that the character model is formed according to the basic character design. Figure 3 shows character model process.
3.3.2 Texturing. The texturing process plays a very important role in making a 3D object look real. Texture creation is done by using Adobe Illustrator CC 2017 with utilizing the UV mapping feature to create a surface pattern of 3D objects. Figure 4 shows the texturing process of a character.

3.3.3 Character Rigging. Rigging is basically a digital framework bound to 3D mesh. This process uses an armature which is a real framework that can consist of many bones. A controller such as Inverse Kinematics (IK) is needed and the union between rigs or bones with characters is called skinning. Figure 5 shows the character rigging process.

3.3.4 Character Animation. Animating is the process of moving characters according to the storyboard. That principle only applies to walking or walk cycle. Figure 6 shows a character in game walk cycle mode. Figure 7 shows visualization of a character on the game.
4 Analysis And Testing

4.1 Alpha Testing

Alpha testing is done by the game maker team to control system errors and ensure the game runs properly and correctly. If there is a system error, it will be immediately repaired. Testing of 3D characters and animation is done with these aspects, as follows:

1. 3D Character Design Testing; to check whether the animation made is in accordance with the concept and storyboard or not.
2. Testing based on 12 Animation principle to check whether the animation that has been made according to the 12 principles of animation or not.

4.2 Beta Testing

Tests were conducted to determine the feasibility of the game for BIPA students. Beta testing was conducted on 21-22 July 2018 by distributing questionnaires to 30 respondents randomly of BIPA student criteria after respondents run the game “Asiknya Berbahasa”. The scale used in this test is a Likert Scale with five response choices namely Strongly Agree (SS), Agree (S), Slightly Agree (AS), Disagree (TS) and Strongly Disagree (STS). Each choice has different values of 5 (SS), 4 (S), 3 (US), 2 (TS) and 1 (STS). The following are the results of the analysis:

Q1. "The character design is suitable as a foreign student"; it's obtained 80% agree that the 3D character is in accordance with the game character reference and there is no answer for "disagree" or "strongly disagree". This proves that the respondent justifies the statement on the questionnaire that the character design is appropriate.

Q2. "The character model's color matches the game's theme"; it's obtained 71.3% agree that the color of the character is in accordance with the theme and there is no "disagree" or "strongly disagree" answer. This proves that the respondent justifies the statement on the questionnaire that the use of color is correct.

Q3. "The character model's texture matches the game's theme"; it's obtained 72.6% agree that the texture of the 3D character game design is in accordance with the theme and there is no "disagree" or "strongly disagree" answer. This proves that the respondent justifies the statement on the questionnaire that the use of the texture is correct.

Q4. "The character movement is good"; it's obtained 59.3% on slightly agree that the movement of the 3D character game is in accordance with what was done. In this question there is 1 respondent stated "strongly disagree" and 2 respondents said "disagree", therefore it will be corrected. This proves that the respondent somewhat justifies the statement on the questionnaire that the character movement is appropriate.

Q5. "Figure in the game already supports game atmosphere"; it's obtained 82% agree that extra chapter of "Fun Speaking" game already supported the atmosphere of the game and there are no "disagree" or "strongly disagree" answers. This proves that the respondent justifies the statement on the questionnaire that extras have supported the game atmosphere.
5 Conclusions
Based on the results of the study, it can be concluded that:
1. 3D models and animated characters in the "Asiknya Berbahasa" educational game have successfully created.
2. Based on the results of alpha testing, the design of 3D characters for speech movements and 3D character modeling shows invalid results when entered in Unity but immediately corrected by changing the position of the vertex and changing the blender file to .FBX.
3. Based on the results of beta testing, the results showed that the respondents agreed with the 3D model and character animation in the "Asiknya Berbahasa" game.

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