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Application of Educational Game as a Mediato Introduce the History of the Equator Monument

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Abstract

Tugu Khatulistiwa is a historical monument that commemorates the equator. Education about it is delivered through photos and historical documents on the monument wall. This research aims to provide an understanding of the history of the Equator monument by utilizing educational games and Augmented Reality (AR) technology. The game development method follows the Game Development Life Cycle (GDLC) with 6 phases: Initiation, production, and release. The educational game contains historical content of the equator monument, while Augmented Reality provides an interactive experience for visitors. The test results showed that the satisfaction level reached 89.85%, with an increase in understanding of 15.5% from the pretest to the posttest. The use of game technology and AR effectively improves visitors' understanding of the history of the Equator monument. This educational game is expected to be more widely known and understood. Thus, educational efforts about the historical value of the equator monument can be better.

Keywords: Game, Equator Monument, Tourism, Interactive Media, Augmented Reality.

1.0 Introduction

Tugu Khatulistiwa, located in Pontianak City, West Kalimantan, is an important monument that symbolizes its geographical location on the equator. As a monument that has high historical and geographical value, the Equator Monument attracts the attention of many tourists and visitors who want to know more about its uniqueness and history. However, despite its potential as a fascinating tourist destination, there is not much information about the history of the Equator Monument. Most visitors have limited access to knowledge and understanding of the Equator Monument.

Historical records of the Equator monument are still traditionally packaged, with photos and related documents displayed on the inner walls of the Equator monument building. There are also limited guides to provide education about the history and flow of development of the equator monument one by one to each visitor. So it is necessary to apply technology that is expected to help provide education to every visitor who comes and provide users with an understanding of the history of the equator monument.

In the era of advanced information technology, the use of educational games and Augmented Reality (AR) technology shows great potential for presenting information that is interesting and easy to understand. Combining game elements with AR technology, an innovative educational game is a powerful tool to introduce and educate visitors about the history of the Equator Monument.

Previous research has shown that the use of educational games can increase users' understanding and interest

in learning. Therefore, this research aims to develop an educational game with the addition of AR features specifically designed to provide an interesting and interactive learning experience about the history of the Equator monument.

Through the development of educational games and AR, it is expected that game users, including tourists and the general public, can better understand the background, meaning, and historical value of the equator monument. In addition, by using AR technology, users get a new experience that is expected to give a positive impression so that it can increase tourist attraction.

In the context of this research, the existing background raises an important question: whether educational games and Augmented Reality of the history of the Equator Monument are effective in educating game users. Therefore, this research aims to contribute to the development of innovative educational games and expand game users' access and understanding of the history of the Equator monument.

2.0 Literature Review

1. Equator Monument

The Equator Monument is a monument built in 1884 by the Governor of the Dutch East Indies, Hendrik Merkus de Kock, to mark the equator in the West Kalimantan region. The monument was built on a hill in the city of Pontianak, which is the capital of the province.

The process of building the monument began with choosing the right location on the hill so that it could be seen from various parts of Pontianak city. Then, workers from the Netherlands worked on the construction using locally available materials, such as stone, clay, and ironwood. After several months, the monument was completedand inaugurated by Governor de Kock on September 23, 1884.

The Equator Monument is now a popular tourist attraction in West Kalimantan. This monument is an important symbol for the local community because it marks the equator which is the boundary line between north and south. The benefit of this monument is as a tourist attraction for local and international tourists. The monument is also an important icon for the city of Pontianak and the region of West Kalimantan, marking the equator and symbolizing the unity of the region.

2. Definition of Game

A game is something that can be played with certain rules such as winning or losing conditions, usually in a non- serious context or for entertainment purposes. A learning method used to analyze interactions between multiplayerand individuals by presenting rational strategies.

"Games are formed from rules used to establish conditions such as winning or losing aimed at individual, group or larger scale competition, the strategies built are aimed at maximizing one's gain or minimizing the opponent's gain. The rules determine

The amount of information each player has, the player receives the progress of the game and the amountof victory or defeat in different situations".

Some definitions of the game according to experts:

1. John C Beek & Mitchell Wade: Games are a proven attention grabber. Games are a good trainingenvironment for the real world in organizations that demand collaborative problem-solving.
2. Samuel Henry: Games are a form of entertainment that is often used as a mind refresher from the fatigue caused by our activities and routines.
3. John Naisbitt: Games are dynamic participatory systems because games have a level of storytelling that movies don't have.

A game generally has a type or category and genre that makes it easy to categorize and divide the type ofgame, types and genres of games include.

4. Game Development Life Cycle

GDLC is a game process that applies an iterative approach consisting of 6 development phases starting from the initialization/concept phase, pre-production, production, testing (alpha testing, beta testing), and release phase.The six stages can be grouped into 3 main processes, namely the initial process consisting of concept and design, the production process consisting of pre-production, production, and testing (alpha and beta) Realease.
The GDLC Guidelines phases and processes can be seen in the following figure:

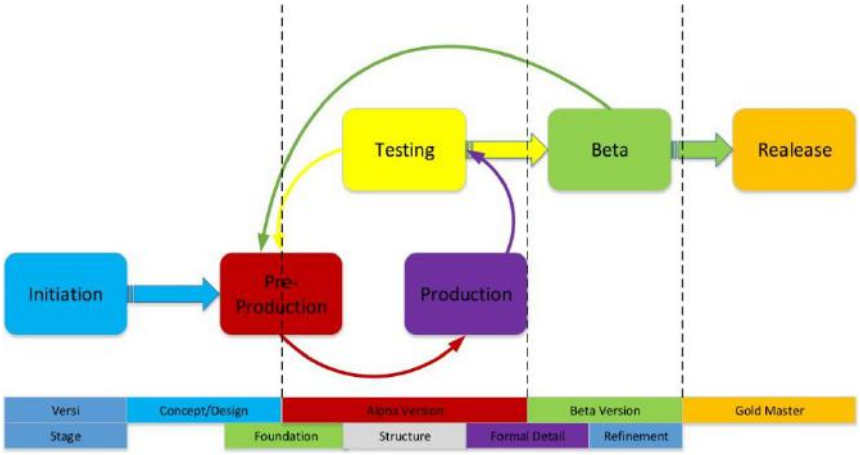


Fig.1 GDLC Phases and Process

5. Augmented Reality

AR (Augmented Reality) is a technology that combines two-dimensional or three-dimensional virtual objects into the real world and projects these virtual objects in real-time. Besides being used in fields such as health, military, manufacturing industry, education, and tourism AR technology is also used in the world of entertainment such as filters available on social media such as Instagram and Snapchat. AR technology can insert specific information into the virtual world and display it in the real world with the help of equipment such as webcams, computers, smartphones, and special glasses.

In general, the methods developed in Augmented Reality are currently divided into two methods, namely Marker- Based Tracking and Markless Augmented Reality.

1. Marker Augmented Reality:The marker is a square black-and-white illustration with thick black borders and a white background. using sensors and devices, the marker will be recognized for its position and orientation and then create a virtual world with a 3D model that has a point (0,0,0) and three axes namely X, Y, and Z.
2. Markerless: One of the new methods in Augmented Reality is markless is a method where users no longer need to use a marker to display digital elements, with the tools provided by Unity users can perform many interactions by adjusting the desired conditions and the availability of tools that make it easier for users to build games.
3. Testing: Testing is the final stage in research to determine whether all planned research components are in accordance or not with the research objectives. In this case, the testing stage is divided into 2, namely Alpha Test and Beta Test.

1. Alpha Testing: Alpha testing is a type of BlackBox Testing that is done to identify all problems/bugs that may occur before releasing the product to end users. The focus of this test is to simulate real users using black or white. The goal is to test features that may be used by end users. Alpha testing is done early on, at the end of software development, and before Beta testing.
2. Beta Testing: Beta testing is a "live" game of software in an environment that cannot be controlled by the developer. Beta testing is done outside the environment that cannot be controlled by the developer, Beta testing

of a product is done by "real users" of the software game in a "real environment". The Beta version of the software is released to a limited number of end users of the product to get feedback on the quality of the product. Beta testing reduces the risk of product failure and provides product quality through customer validation.

Beta testing is the final test before delivering the product to users. The main advantage of Beta testing is that it canreceive feedback from end users.

3.0 Research Method

In this research, the method used in game development is the Game Development Life Cycle, with stages of initiation,pre-production, production, alpha testing, beta testing, and release.

An image of the GDLC Phase can be seen in Figure 1.

1. Initiation

This game was built using materials from the Equator Monument Committee and books. This game is designed based on the history of the construction of the equator monument, which involves several stages with their respective stories and roles. This game also utilizes information about a rare and unique phenomenon at the equator monument called culmination, as a special attraction. This game was developed for Android smartphones with a portrait screen model so that visitors can play it while traveling at the equator monument. The genre of this game is a puzzle, which contains pieces of images of the Equator monument, and a Quiz that provides historical education about the Equator monument to visitors. This game also uses Augmented Reality as an interactive medium to interact with markers on the equator monument.

All of the above information is summarized in the following table:

TABLE I

Initiation table

No	**Element**	**Keterangan**
1	Genre	Puzzle
2	Layout	Potrait
3	OS	Android
4	Content	History of the Equator Monument
5	*Game* Engine	Unity
6	*Game* Type	Education
7	AR Marker	Marker, Markerless

2. Pre-Production

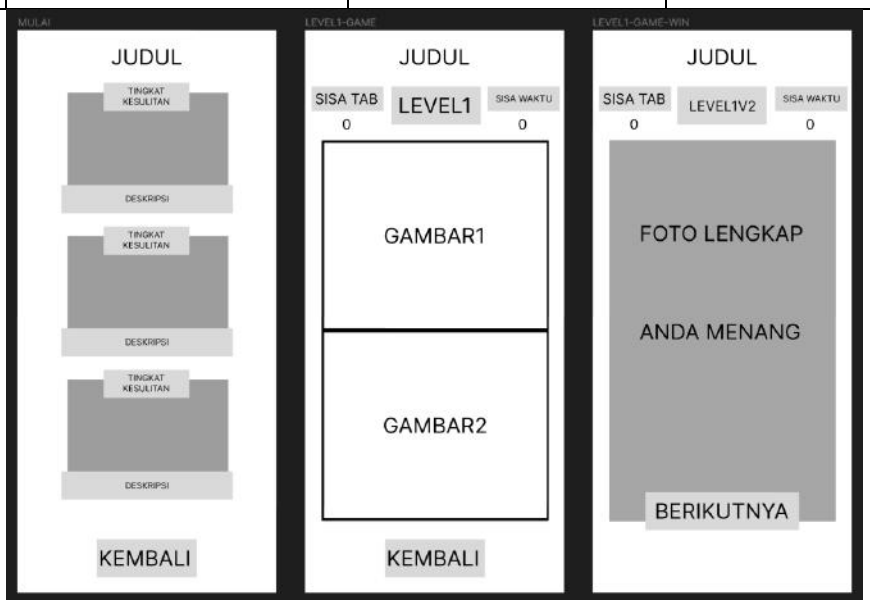
In this stage, the prototype and components needed to make the game in the production or implementation stage are built. It is necessary to map the needs of each part of the game so that the prototype can be made appropriately.

TABLE 2

Pre-production Table

No	**List Scene**	**Functional Needs**	**Asset Requirements**
1	Menu	Move	Theme Music
2	Tutorial	Back	Game Music
3	Start	Move to Menu	Sound Effects
4	Ar	Next	Background

5	Info	Play Music	Logo
6	Level Menu	Play Sound Effects	Button Image
7	Easy Level	Win Condition	Text
8	Difficult Level	Lose Condition	
9	Very Difficult Level	Game Exit	
10	History Info		
11	Quiz		
12	Character Introduction		
13	About the Game		



Prototype in the Pre-Production stage

3. Production

The production process in the Game Development Life Cycle (GDLC) is the implementation stage of the pre-production and design. At this stage, various important elements such as asset creation, program code writing, and the incorporation of all aspects into each scene are carried out according to the planned game requirements.

One important aspect of the production process is asset creation. Assets can include characters, objects, backgrounds, animations, visual effects, sounds, music, and so on. A team of artists and designers work together to create or collect these assets, either by using specialized software such as graphic design software, animation, or even by photography and sound recording techniques.

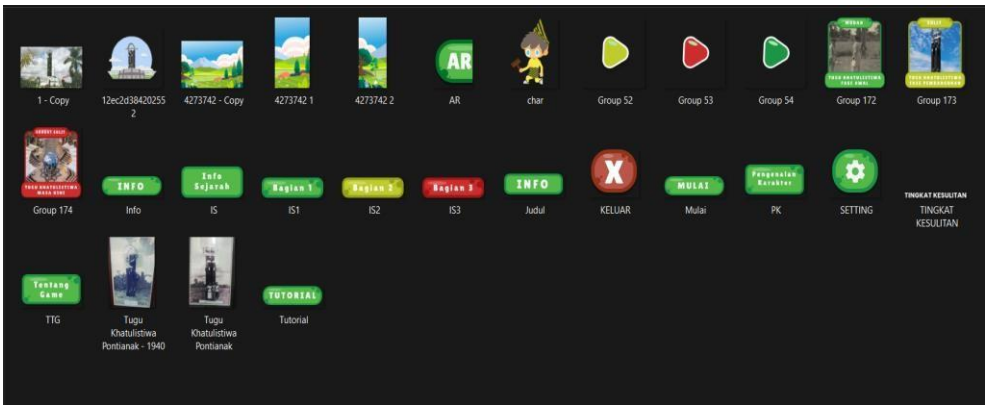


Figure 3. Assets Game.

In addition, the production process also includes the creation of program code that will manage the logic of the game and the interaction between the player and the game environment. This program code is written using the C# programming language. The coding process involves setting up game rules, control mechanisms, and artificial intelligence, as well as integration with audio systems, graphics, and other features. After the assets and program code were completed, the next step was to combine all these aspects into each game scene. At this stage, we arrange the visual and audio elements into a unified scene. We positioned the characters, objects, and backgrounds, and applied the appropriate visual and sound effects. The ultimate goal is to create an immersive and satisfying gaming experience for the player.

4. Alpha Testing

Testing in this context means internal testing conducted to test the usability of the game and launch it on the target platform. Formal detailed testing is done with playtests to assess the functionality of features and the difficulty of the game (related to balance). The method of testing functional quality criteria is through the game's testing function, i.e. full internal quality criteria testing, which can be done alongside testing the game with functionality testing (*Blackbox Testing and White Box Testing*).

Accessibility can be tested by observing the behavior of the researcher. If the tester finds it difficult to play and understand the game, the game is not accessible enough. The outputs of testing are bug reports, change requests, and development decisions. The results determine whether it is time to move on to the next phase (beta) or repeat the production cycle.

5. Beta Testing

Beta is the phase The third or outermost test. Beta testing still uses the same test methods as the previous tests. Beta testing is a formal refinement and refinement of details. Beta testing begins with the selection

External testers are divided into two parts: closed beta testing and open beta testing. Only invited people can participate in the closed beta, all registered people can participate in the open beta. During the formal part of testing, testers are asked to find defects (related to complete functional and internal quality criteria). Testing gives testers more freedom to enjoy the game as the goal is to get more feedback (accessibility and fun quality criteria).

6. Release

The final stage of all *game* development processes is when the *game* is released to the public. Release involves product launch, project documentation, knowledge sharing, post-mortems, and planning for game maintenance and expansion.

4.0 Results And Discussion

1. Implementation

Implementation is the next stage after software design. The required functions are then converted into a programming language according to the software requirements. The implementation stage is carried out in stages according to the system requirements that have been previously determined.

The stages carried out during game development start from creating game objects from photo data of the development of the Equator monument from ancient times to the present, and photos of the culmination phenomenon that occurs at the Equator monument. Making game objects is done by cutting the image into a cube shape so that each side has the same length. After the game object asset is complete, it will be exported so that it becomes JPG or PNG format as needed.

After the asset creation stage is complete, the next step is to create a game project in the Unity hub, where the developer menu that is selected is Unity 2D. Then import all assets that have been created and prepared including audio. After all assets are imported, it is necessary to configure the game project so that it can be run on Android and adjust the asset size to the minimum specifications that will be run.

The next step is programming or creating a program script for each event or function needed so that the game can run as it should, after the program stage is complete, it will continue with making animations so that the game becomes more interesting and gives a pleasant impression to the user. Then the debugging project is carried out using a smartphone to test whether the game is what was designed at the beginning, debugging is also done to check for errors, and incompatibility of the display on the laptop / PC with the display on the smartphone. And if there is a difference, it will be resolved immediately.

The final step of this stage is export, after going through various stages, this game is declared ready for the next stage. Namely the Alpha and Beta testing stages to ensure the final results of this game can run after doing some testing.

Figure 4. Splash Screen Page

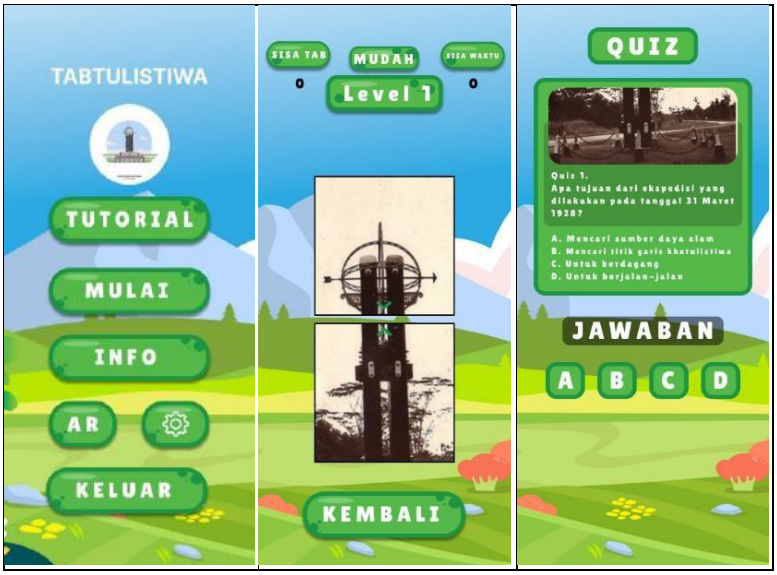


Figure 5. Menu page (left) Gameplay page (center) *Quiz* page (right)

After the player presses the start button, the player will be directed to the level menu page where the player can start the game from the easy level, after the player completes the level the *game* will display the historical information page and quiz for the player to complete the level.

Figure 6. Level Menu page (left) Quiz page (center) AR page (right)

When the player completes the entire level challenge, the next level and AR button will open according tothe level completed. The difficulty level of each level will be different to provide challenges to players to complete it. The historical info page at each level has different information to provide new understanding.

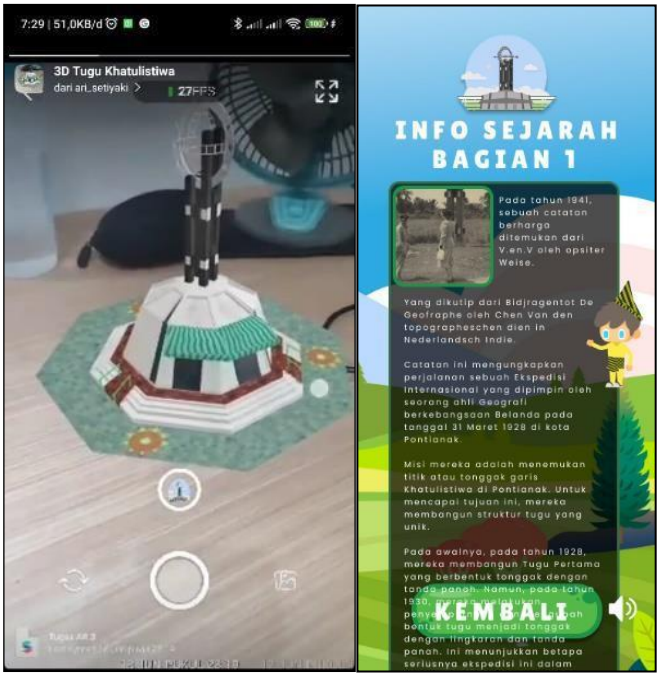


Figure 7. AR display (left) and *quiz* page (right)

2. Alpha Testing

Referring to *Black Box* testing, *Alpha* testing in this study uses a test table where each function in each scenewill be tested whether it runs smoothly or not before proceeding to the *Beta* testing stage.

TABLE 3

Table *Scene List Test*

AT-ID	**Scene Name**	**Testing Type**	**Results**
AT-1	Menu	Function Testing	Sukses
AT-2	Tutorial 1	Function Testing	Sukses
AT-3	Tutorial 2	Function Testing	Sukses
AT-4	Tutorial 3	Function Testing	Sukses
AT-5	Tutorial 4	Function Testing	Sukses
AT-6	Level Menu	Testing Function	Sukses
AT-7	Easy Lv1	Testing Function	Sukses
AT-8	Easy Lv2	Testing Function	Sukses
AT-9	Easy Lv3	Testing Function	Sukses
AT-10	Difficult Lv1	Testing Function	Sukses
AT-11	Difficult Lv2	Testing Function	Sukses
AT-12	Difficult Lv3	Testing Function	Sukses
AT-13	Very Difficult Lv1	Testing Function	Sukses
AT-14	Very difficult Lv2	Testing Function	Sukses
AT-15	Very Hard Lv3	Testing Function	Sukses
AT-16	Info	Testing Function	Sukses
AT-17	Character Introduction	Testing Function	Sukses
AT-18	History Info 1	Testing Function	Sukses
AT-19	History Info 2	Testing Function	Sukses
AT-20	History Info 3	Testing Function	Sukses
AT-21	About the Game	Testing Function	Sukses
AT-22	AR	Testing Function	Sukses
AT-23	Quiz 1	Testing Function	Sukses
AT-24	Quiz 2	Testing Function	Sukses
AT-25	Quiz 3	Testing Function	Sukses
AT-ID	**Scene Name**	**Testing Type**	**Results**
AT-26	Finish Page 1	Testing Function	Sukses
AT-27	Finish Page 2	Testing Function	Sukses
AT-28	Finish Page 3	Testing Function	Sukses

Beta testing is carried out outside an environment that cannot be controlled by the developer where in this test 2 stages will be carried out, namely the pre-test and post-test stages. In the pre-test, respondents will be given questions about the equator monument before playing the game, and given a post-test with the same questions after playing the game to see the results of Beta testing. The source reference used in the pre-test and post-test questions is material from the Equator monument management in the form of photos containing text on the history of the development of the Equator monument.

Beta testing was also carried out to test the functionality of the game. This test uses a sample of 20 respondents, with the consideration that the scope of the equator monument is small, and the number of visitors is only crowded on certain days.

TABEL 4

Tabel *Pre Test*

PRE-TEST 10 QUESTIONS					
NO	**NAME**	**CORRECT**	**x 10**	**FINAL VALUE**	**GOAL VALUE**
1	Aldi	3	10	30	100
2	Indra	4	10	40	100
3	Dini	5	10	50	100

NO	**NAME**	**CORRECT**	**x 10**	**FINAL VALUE**	**GOAL VALUE**
4	Fitri	6	10	60	100
5	Wahyu	7	10	70	100
6	Kasnawi	8	10	80	100
7	Gita	3	10	30	100
8	Sella	4	10	40	100
9	Bima	5	10	50	100
10	Abdul	6	10	60	100
11	Fuxen	3	10	30	100
12	Andi	4	10	40	100
13	Ulfi	5	10	50	100
14	Hesti	6	10	60	100
15	Fahmi	3	10	30	100
16	Dimas	4	10	40	100
17	Arni	5	10	50	100
18	Kiki	6	10	60	100
19	Bagas	4	10	40	100
20	Ella	7	10	70	100
WEIGHTED SCORE				980	2000
AVERAGE SCORE				49	

Based on the pre-test data above, the following information is obtained: Users get a weight of 980out of a total weight of 2000, so it has a percentage of (980/2000)x100% = 49%

TABLE 5

Post Test Table

PRE-TEST 10 QUESTIONS					
NO	**NAME**	**CORRECT**	**x 10**	**FINAL VALUE**	**GOAL VALUE**
1	Aldi	4	10	40	100
2	Indra	5	10	50	100
3	Dini	6	10	60	100
4	Fitri	7	10	70	100
5	Wahyu	8	10	80	100
6	Kasnawi	10	10	100	100
7	Gita	5	10	50	100
8	Sella	6	10	60	100
9	Bima	7	10	70	100
10	Abdul	8	10	80	100
11	Fuxen	7	10	70	100
12	Andi	8	10	80	100
13	Ulfi	4	10	40	100
14	Hesti	5	10	50	100
15	Fahmi	6	10	60	100
16	Dimas	7	10	70	100
17	Arni	8	10	80	100
18	Kiki	4	10	40	100
NO	**NAME**	**CORRECT**	**x 10**	**FINAL VALUE**	**GOAL VALUE**
19	Bagas	7	10	70	100
20	Ella	7	10	70	100
WEIGHTED SCORE				1290	2000
AVERAGE SCORE				64,5	

POST TEST 10 SOAL

Based on the pre-test data above, the following information is obtained: Users get a weight of 1290 out ofa total weight of 2000, so it has a percentage (1290/2000) x 100% = 64.5%.
The percentage increase obtained from testing the pre-test with the post-test has the following value:

Increase value (Post-test - Pre-test) = 64.5% - 49% = 15.5%

TABLE 6

Table *Beta Test*

No	Statement	Answer					Total
		1	2	3	4	5	
Variabel Funcitonality							
1	Game can display 3 difficulty levels				14	6	20
2	Game can display puzzle gameplay			2	9	9	20
3	Game can display history info page			1	11	8	20
4	Game can display Quiz gameplay			4	7	9	20
5	Game can display tutorial page			3	7	10	20
6	Game can display AR page			1	8	11	20
No	**Statement**	**1**	**2**	**3**	**4**	**5**	**Total**
7	Game can display character introduction page			4	5	11	20
8	Game can display about the game			4	6	10	20
9	Every feature/menu and button can run			2	3	15	20
Variabel Efficiency							
10	Each process requires a short time lag			1	5	14	20
11	The response of each process is in accordance with its function			2	7	11	20
Variabel Usability							
12	Clarity in operating existing features			5	1	14	20
13	Provides information that is easy to understand			3	2	15	20
14	The use of display per menu/feature iseasy to learn			2	5	13	20
15	Easy to learn/play games			1	3	16	20
16	Completeness of the operation menu				9	11	20
17	The animation of moving menus/features is interesting			2	4	14	20
Variabel Portability							
18	Ease of installation			1	5	14	20
19	Game can be installed successfully			1	3	16	20
20	AR can run smoothly			4	3	13	20
Total				43	117	240	400
Weight				129	468	1200	2000

Based on the results of the *Beta* tester from 20 users, the following information can be found:

The total user weight is 1797 out of a total weight of 2000, so it has a percentage (1797/2000) x 100% = 89.85%.

Standard option chosen by the user weighs 129 and has a percentage of (129/2000) x 100% = 6.45%.

The good option chosen by users has a weight of 468 and has a percentage of (468/2000) x 100% = 23.4%.

5.0 Conclusions

After testing and analyzing the topic of the final project with the title Application of Educational Games as a Media to Introduce the History of the Equator Monument, it can be concluded as follows:

1. The application of Educational Games as a Medium to Introduce the History of the Equator Monument has

successfully helped provide understanding to users with various features provided in the game. The results can be seen from the beta testing of the pre-test and post-test stages.

2. The author succeeded in making the Application of Educational Games as a Medium to Introduce the History of the Equator Monument can provide education to users by packaging the information in a technology that is being widely used and has the opportunity to continue to grow in the future.
3. Alpha testing with the scene list on all scenes was successful.
4. Beta test which is divided into pre-test and post-test which is made to introduce basic knowledge and comparison after playing educational games as a medium to introduce the history of the equator monument has a positive impact, with 20 users as respondents. A percentage of 89.85% was obtained in the satisfaction aspect and a 15.5% increase in the post-test which indicates that this game has succeeded in educating users or visitors to the equator monument as expected.

Future Scope & Acknowledgement

In its development, this *game* still has many shortcomings and limitations that are expected to be utilized for development in other studies, with the following suggestions:

1. *The game* only runs on the Android operating system but can be developed again so that *the game* can run on operating systems other than Android.
2. Add better animations, especially in transitions and when starting a gameplay.
3. Future research can develop more than 2 types of gameplay so that users have the freedom of comfort of what kind of gameplay content they want.
4. *Games* can be developed to exchange moments with other visitors.

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