Applying Gamification Technique and Virtual Reality for Prehistoric Learning toward the Metaverse

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***Abstract*—Technological development provides many benefits in learning process, such as the development of the learning method, media, strategy, and design. Based on the observation had been done at History department, UNDIKSHA showed that the students had problems in learning process especially in Indonesian Prehistory Course. The lecturer still focused on teacher-centered method and book only without using technological development. That is why, students' interest, motivation, and understanding towards the learning process could be categorized as low. This research aimed to describe the implementation of gamification technique and virtual reality in developing an educational game to help students in recognizing the prehistoric objects, increasing the students' motivation and activeness, and giving immersive experience learning toward the metaverse. This research used ADDIE Model method and was analyzed by using descriptive quantitative and qualitative. The subjects were 20 students of the History department at UNDIKSHA. The result showed that the average response of the 20 users was 91.81% which could be categorized as very positive. The effect score was 0.80 which could be categorized as very effective. It was counted by using N-Gain Score. So, gamification based on virtual reality could increase the students' activeness, interest, motivation, and understanding toward the prehistoric objects.**

***Index Terms*—Gamification, metaverse, prehistoric objects, virtual reality.**

I. Introduction

Technological development provides many benefits in learning process. There are many new learning method, media, strategy, and design can be implemented in the learning process. Yet, there are still problems faced by students in the learning process. The educators still use traditional method which is teacher-centered, book as the main source, and lack experience for the students in the learning process [1, 2]. The students can feel bored easily when the learning process is not fun, interesting, and effective [1]. Although the learning subject is fun for the students but when the learning method and media are not effective and efficient, the students cannot follow the learning process well [1]. That is why, the educators must be able to develop their learning method, media, strategy, and design by using technological development. So that, it can give many benefits for the students' interest and motivation in the learning process.

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History is one of subjects that must focus on many scientific sources and also real objects to get better experience and knowledge [3]. That is why, the historians suggest that the great method for the students to get better experience and knowledge is by visiting historical places or known as study tour [3]. Yet, it is hard to be done because there are many preparations namely, we need a lot of parties and fund for supporting this activity [3]. Furthermore, Covid-19 still becomes the big problem, we have to do many health protocols if we want to do this activity.

One of the solutions can be given is by providing interesting learning media. Videos are often used as media in providing material in the form of illustrations or dynamic visuals and audio. Based on the observation that had been done at History Department, Universitas Pendidikan Ganesha (UNDIKSHA) showed that the learning media in the form of video for Prehistory Course was quite difficult to be found because there was no video documentation at all. Several researchers created 3D animation videos to represent the prehistoric era both in terms of human life to its prehistoric objects to add insight to students but it did not give maximum results. Prehistory Course must be increased by implementing the technology development which can be in the form of real observational and experience effect so that the learning process can be more interesting and effective. Furthermore, technology can give interactions between the players (students) and the content or learning material to improve their understanding towards the learning material [4].

In the current digital era, educators are expected to be creative and can integrate technology into the learning process that combines content, pedagogy, and technology knowledge (TPACK), so that the learning process becomes fun and meaningful [5]. An educational game or often called Gamification is a form of educational game that can provide a learning experience for the players and particularly involves students. Gamification is useful to enhance the motivation and performance of the students in the learning process in the formal and informal contexts [6]. Gamification is also related to the technique of playing applied in a project, learning, or particular situation [7, 8].

There are various studies have been undertaken to implement educational games, one of them is educational games for early childhood education. Although the game results created have not been varied enough and the environments have not been detailed but the other educational games for early childhood education have also been created, but still on the Android platform [9, 10].

Currently, there are some game-making technologies have developed very fast. The frameworks are commonly used are Unity, Unreal, Gonstruct2, Stencyl, etc. These can be used on

various platforms without making the game application repeatedly. Besides, framework technology for making games has currently been equipped with various features to create games with special effects, such as 2D and 3D to make it more interesting and detailed [11].

This game-making technology can be developed in gamification for introducing prehistoric objects. So that the students can get real experience towards the prehistoric objects by using virtual world environment simulated by a computer [12]. The students will feel the sensation of the virtual world, and by looking at the current development of virtual reality technology, it is made possible for the visual and audio sensory organs to feel the real sensation of the virtual world [6].

There are some regulations have to be followed in applying the game mechanism to achieve a certain level. In gamification, rewards can be shown on the ranking board, badges that have been won, and loyalty programs that encourage students to appear and have fun based on the learning scenario [13, 14]. Furthermore, gamification is also associated with the enhancement of motivation and qualifications that the students have achieved. They need learning motivation, feel the experience and success in struggling in meeting the existing challenges and how to overcome difficulties at every level, which is then continued to the next level [15].

There are several studies have been conducted on gamification in education research. Gamification applied in Software Engineering education can maximize the potential of psychomotor in practical learning [8]. Gamification to be a tool used in the study in the industry 4.0 and education 4.0 paradigm that has an impact on learners' active learning process [15, 16]. The obstacles experienced in the learning process with gamification are the ones that tend to be boring to go through at each level of gamification. Furthermore, lack of image rendering and animation also affects gamification in its use.

The gamification does not only apply to practical learning but it can be applied in cultural learning processes, namely historical lessons. Gamification is very innovative media for learning history. It is because the users can directly see illustrations in the form of historical objects. Gamification consists of reality content which can make the users see the texture of historical objects in more detail because of 3-dimensional textures. So that, the students will feel interest and enjoy in following the History course.

This study described the development of an educational game application (edutainment/gamification) "*Penjelajah*", which is Introducing Prehistoric Objects based on virtual reality to enhance the students' motivation, activeness, and immersive experience in the learning process. The main feature of this game is the player can see the forms, names, and descriptions of prehistoric objects found and which are also available in a mini museum that contains collections of prehistoric objects that have been collected during the game. The game is an educational game that was designed to make it easy to be played, uncomplicated, and can be used without a disturbance on performance such as a long loading time. The structure of the game that was designed followed the structure of games in general, to produce active, innovative, and joyful learning.

The development of educational games has a great potential in creating an innovative and joyful learning condition since the educational game contains an integration between animation and narration that makes students interested so that this can enhance their attention and motivation to learn the lesson and give implication on the enhancement of learning achievement [8, 17, 18]. Educational games can support the educational process since they are excellent in some aspects compared to the conventional learning method. One of the superiorities of the presence of animation is that can enhance memory so that the students can store material for a long time compared to the case when the students learn from the conventional learning method [19]. Hence, the development of this educational game becomes an alternative for the teacher in changing the conventional teaching method into an instruction based on educational games so that it can develop students' creativity with the presence of challenges, precision, reasoning, and ethics.

Technological developments that are increasingly developing until now are heading to the metaverse. Metaverse becomes the beginning of a new world to explore and move virtually [20]. The metaverse is now leading to education [21]. This virtual world is hoped that learning will be carried out from anywhere, anytime, and with anyone without any boundaries [21].

II. Literature Review

A. Humanistic Learning Theory

The learning process is considered successful if the students can understand the learning material and there is value and benefits for them in real life. The students must be able to develop their selves in the learning process, so that they can get the learning goals. Furthermore, teachers have important role in the learning process because they will deliver the learning material, if they are not able to develop the learning process, then the education quality cannot develop properly [22]. The teachers must be able to understand the students' need and want in the learning process. So that, the problems in the learning process can be solved properly. By using gamification, each individual can understand themselves, and arouse curiosity, and potential in themselves.

B. Dale Cone Experience Model

Knowledge acquisition, attitude and skill changes can occur due to interactions between new experiences and previous experiences. There are three main levels of learning mode, namely enactive experience, image/pastoral experience (iconic), and abstract experience (symbolic) [23]. The learning process can be successful if students are invited to make use of all their sensory tools. In line with this theory, Augmented Reality provides a learning experience that utilizes all the sensory tools of learners' learning.

C. Educational Game

Educational game can be defined as form of games made to provide a learning experience for the players, that is given

educational content. Educational game is a very pleasurable activity because it is an educational method or medium that educates the student by improving their critical thinking skill and also activeness in participating positive activities [17].

Educational game is very interesting media in the learning process because it has many superior aspects. One of the significant superiorities in the presence of animation is it can enhance memory so that students can store learning material for a longer time compared to the conventional learning method [24]. The teacher also can develop students' creativity because game has the elements of challenge, precision, reasoning, and ethics. The educational game has positive functions and usefulness for the students, which include the fact that the students will be familiar with computer technology. They will also learn to follow some instructions and rules. They train themselves to solve problems. Furthermore, they can develop their interactions and communications between parents and children while playing together because it gives entertainment as healing therapy.

The designing of a good educational game has to meet the following criteria as follows [25].

1) Overall value

The overall value of a game is centered around the design and the duration of the game. This game is built with a good and interactive design. The main features of the game include the fact that the players can see the forms, names, and also descriptions of the prehistoric objects found. They are also available in the mini museum room that contains collections of prehistoric objects that have been collected during the game.

2) Usability

Usability focuses on the how easy to use and to be accessed because it is the important point for the game maker. This application is designed with a user-friendly interface so that the user can easily access the application (game) and it can be used without broken images and disturbances in performance such as a long loading time. The structure of the game that is designed also follows the structure of the game in general, to realize active, innovative, and joyful learning.

3) Accuracy

Accuracy means the extent of the success of game model/picture which can be conveyed in the try-out or the designing process. The design of this model has to follow the model of the game at the planning stage.

4) Appropriateness

Appropriateness means the content and design of the game can be adapted well to the users' need. This application provides the menu and features that are needed by the user to help them in using the application.

D. Unity, HTC Vive and Blender

Unity is an application that is used to develop a multiplatform game that is designed to make it easy to use. Unity is good and is full of interest in professional applications. The editor in Unity is made by using a simple user interface. This editor is made after thousands of hours to make it number one in the top rankings for game editors. The features that Unity 3D has include rendering, scripting, asset tracking, platform, and asset store.

HTC VIVE is hardware that can see and move around a space-scale virtual environment. The physical location is traced so that we can explore and interact deeply in the fantasy world. HTC VIVE consists of a headset, controllers, and base stations that are needed to connect with the virtual environment [26].

Unity is one kind of tool, considered an ultimate one for it helps in coming up with interesting games and various interactive 3D content. Unity, a completely integrated development framework provides rich solutions that give out-of-the-box functionality and help in creating games [27]. One can use this framework to assemble audio, and special effects, add lighting, animation, and concomitantly play, test, and edit the game if necessary. If you feel fine about every aspect of the game, and it is ready, the game can be published on the chosen platform.

In our case, it has been used to create artifacts, environments, enemies, and the game itself. It is created by using Blender, an open-source 3D computer graphics software toolset mainly used for creating 3D models and animations. After the 3D object is created, then we export it to FBX (film box) format because Unity has recommended the developers use the FBX format for importing 3D content easily all of the 3D objects ae made carefully to extend the quality of gaming.

This combined with HTC Vive has more advantages than other VR devices like 6DoF controllers, room-scale tracking, and simulating the movement of the player's head making players able to get a more immersive gaming experience than before. They pick objects in the game by using their hands in the same way as picking objects in real life, opening a chest, using a bow and arrow, and many more [28].

As developers, we firstly studied which platform or tools could be used for an animation subject. Unity is a game engine creator that allows users to create amazing games and virtual worlds and then build them into PC games. We used this software to create worlds with the content made by ourselves, after which players can access and visit this world to collect and learn about prehistoric artifacts. This experiment, combined with HTC Vive creates an amazing and immersive experience.

A blender is computer software with open-source 3D graphics free below the GNU operation system (General Public License). Blender can be used for modeling, UV unwrapping, texturing rigging, water simulator, raster graphic simulation fluid, smoke simulation, camera tracking, skinning, animating, rendering, particle, and for making interactive 3D and video games.

In this study, Blender software was used to make objects and animation objects in the educational game '*Penjelajah*". Blender was used since it has 3D modeling, rigging, and animation features. In addition, Blender is easy to be used, it has an installation measurement that is relatively small and can be implemented on all platforms.

E. Virtual Reality (VR)

Virtual Reality (VR) is the use of computer technology to create a simulated environment. Virtual Reality is the most

immediately-recognizable component which is the head-mounted display (HMD) [29]. Human beings are visual creatures, and display technology is often the single biggest difference between immersive Virtual Reality systems and traditional user interfaces. Major players in Virtual Reality include HTC Vive, Oculus Rift and PlayStation VR (PSVR). Virtual reality (VR) technology is a growing force beyond entertainment and an important tool in education, science, commerce, manufacturing, and more. Learn the basics and the latest from experts about how VR impacts your world [30].

The three main VR categories are the following i) Non-Immersive Virtual Reality: This category is often overlooked as VR simply because it is so common. Non-immersive VR technology features a computer-generated virtual environment where the user simultaneously remains aware and controlled by their physical environment. Video games are a prime example of non-immersive VR. ii) Semi-Immersive Virtual Reality: This type of VR provides an experience partially based in a virtual environment. This type of VR makes sense for educational and training purposes with graphical computing and large projector systems, such as flight simulators for pilot trainees. iii) Fully Immersive Virtual Reality: Right now, there are no completely immersive VR technologies, but advances are so swift that they may be right around the corner. This type of VR generates the most realistic simulation experience, from sight to sound to sometimes even olfactory sensations [11].

Games are not new learning interventions. Face-to-face training has used games for a long time, and with the advent of online learning, two primary modes of gaming evolved. One is pure game-based learning, where the entire training is a game with points and rewards. The other gamifies certain assessments or activities. Organizations have experimented successfully with both forms.

Corporate training can improve its effectiveness by combining VR and gamification can be effectively combined in the world of learning. VR offers the ability to explore unchartered territories and locations that are difficult to explore physically. Adding game-based elements, such as scoring, timed activities and rewards, can help improve motivation and learning. If trainees are pitted against each other in a gamified competition inside a VR environment, they will be more engaged.

F. Metaverse in Education

The metaverse is a concept of a persistent, online, 3D universe that combines multiple different virtual spaces [20]. The metaverse will allow users to work, meet, game, and socialize together in these 3D spaces. The metaverse would also benefit from the use of crypto wallets, such as Trust Wallet and MetaMask. Furthermore, the blockchain technology can provide transparent and reliable governance systems. Video games offer the closest metaverse experience currently because of the emphasis on 3D virtual reality. Video games now offer services and features that cross over into other aspects of our lives. The video game Roblox even hosts virtual events like concerts and meetups. Players don't just play the game anymore; they also use it for other activities and parts of their lives in "cyberspace".

Students and teachers alike can meet up in the digital space via their virtual reality headsets regardless of their real-life location. Such functionality can lead to enhanced education for those willing to seek it [21]. A persistent alternate reality presents endless possibilities, with an especially large potential impact on education. Let's envision one of the possible virtual reality classrooms. Imagine a classroom full of students eager to learn about history. These students are based in various countries around the world, and their teacher lives a traveling lifestyle constantly visiting new areas to increase their historical knowledge.

Teachers can build virtual landscapes based on their lesson plans, enhancing a child's learning with experience as opposed to reading from a book [31]. Teaching and learning in the metaverse may sound like a far-off concept possible only in our dreams, but similar situations already exist in our current landscape. A virtual learning environment allows for anyone to log in from anywhere an advantage shared by current metaverse learning environments. A metaverse environment, however, can be designed to look quite realistic. Depending on their metaverse of choice, educators will have the capabilities to design an environment that's truly stunning and bound to captivate students old and young.

G. ADDIE Model

Educators and instructional designers alike have used the ADDIE Instructional Design (ID) method as a framework in designing and developing educational and training programs. "ADDIE" stands for Analyze, Design, Develop, Implement, and Evaluate. This sequence, however, does not impose a strict linear progression through the steps. Educators, instructional designers and training developers find this approach very useful because having stages clearly defined facilitates implementation of effective training tools. As an ID model, Addie Model has found wide acceptance and use [32].

The ADDIE model was based on an earlier ID model, the Five Step Approach, which had been developed by the U.S. Air Force. The ADDIE model retained this five-step feature, and included many sub-stages within each of the five broad phases. Due to the hierarchical structure of the steps, one had to complete the process in a linear fashion, completing one phase before starting the next [33].

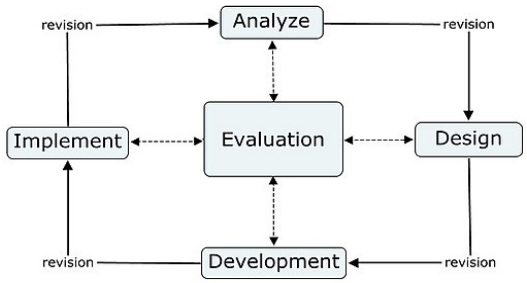

Fig. 1. ADDIE model.

III. Research Method

This research was development research by using ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model. Each of the stages of the model: analysis, design, development, and implementation went through the

evaluation stage (shown with the broken arrow) first, before continuing to the next stage (following the full arrow, starting from the Analysis stage).

The analysis stage was done to analyze the game called "*Penjelajah*" in Introducing Prehistoric Objects Based on Virtual Reality. In this game, the player interacts with the virtual world to do exploration in the game area to look for pre-historic objects. For the content need, the present researchers also did a structured interview with a lecturer of History Education at *Universitas Pendidikan Ganesha* and distributed questionnaires to 20 respondents that consisted of the students at History department, *Universitas Pendidikan Ganesha.* All respondents were collected by using random sampling techniques from the total population of all students in the History Education study program in *Universitas Pendidikan Ganesha.* Then at the design stage, the researchers designed the outline of the game that contented a functional model of software, navigation structure, game scenario, and interface design. In the development and implementation stage, the outline that was still conceptual in the design stage was realized into a prototype that was ready to be implemented through the development of assets used in Gamification such as 1) music and sound effect that used Audacity application, 2) Graphics using GIMP and Blender applications, 3) game engine using Unity and Steam R SDK applications. The last stage was an evaluation of the content of the learning: content expert judgment, media and design expert judgment, and user response testing. In addition to an evaluation at every stage, evaluation was also done the formative way that consisted of three stages: i) validity testing through content expert judgment, design expert judgment, design and media expert judgment; ii) functionality testing was done through the white box and back box testing and iii) effectiveness testing through pretest-posttest testing and user response. White box testing was done using a test case design method through an internal data structure to guarantee its validity. While the Black box testing was done by five people outside of the researchers to test whether the truth of the process met the expectation. The effectiveness testing was done through pretest-posttest done by 20 respondents who answered the multiple-choice items that were related to 5 topics of prehistoric objects, such as names of prehistoric objects, their functions, locations where they were found, the process of making the objects, and the forms of the objects. The topics about the names were tested with 5 items; the functions with 3 items; the location where the objects were found with 2 items; the process of making the objects with 5 items; and the forms of the objects with 5 items.

IV. Result and Discussion

The analysis stage identification of the learning problems in History Education was done by interviewing one of the lecturers and distributing questionnaires to the students. The questionnaire was related to the students' prior knowledge about the prehistoric objects in Indonesia and the process of learning them so far. From the analysis of the data from the questionnaire, it was obtained that i) the students had problems imagining the prehistoric objects, and ii) saturation in learning the prehistoric material which was mostly presented in the form of text and simple drawings so that it was less interesting. One of the solutions offered was through the development of an educational game "*Penjelajah*" based on virtual reality that can present some points as follows: 1) the ability to display prehistoric objects and their information in 3D, which makes the students/players able to get a real effect from their original forms without difficulties in imagining the forms of the objects; 2) the students can pick and hold the prehistoric objects using certain tools in the game; 3) the game can display the main menu that contains things starting from the game, tutorial, information about the game and outside the game; 4) in the game the students can display the information about the game is over, the level of the game and change the account; 5) the player can see the prehistoric objects that he or she could collect during the game in a mini museum. In the need analysis in this gamification, there was also no functionality of the system such as i) usability, in order the application can be used easily, uncomplicated, using the structure designed like games in general; and ii) performance, the application can be used without any disturbance such as a too long loading.

The design stage focuses on the design of the navigation structure model, storyboard, and interface. The navigation structure is the plot of the application that makes it easy in analyzing the interactivity of all objects in the application and the effect of the interactivity on the user. Then storyboard is the plot/scenario of the game at every level toward the next level. The scenario is used for the game to be easily directed as a plot of conveying the material so that it does not become wider so that it can be understood easily.

The development stage and the implementation stage continue the design made to become something that meets the functionality need that has been determined. The interface of the main menu is displayed to the user that contains some menus starting from Game, Tutorial, Information about Game, Change of Account, and Exit from the application (Fig. 2).

Fig. 2. The interface of the main menu of gamification.

The two controllers function as tools to interact with the interface and the environment such as teleportation to a certain location. The display of this tutorial area is then displayed in virtual reality. The player is directed to the backyard of a house that contains three stages: a tutorial to pick an object, a tutorial to open the box, and tutorial to use an arrow, and a tutorial to use a controller that functions as a bow that will be chosen by the player. The player has to

complete the tutorial stages one by one, if the three tutorial stages have been completed then the player can come back to the main menu. The button will close the interface menu on how to play and display the interface of the Main Menu. In user, an icon will be displayed if the user chooses the user icon in the main menu. The function of this account is for the player to be able to make a new account or to contain data on the player that has existed. The player interacts by using the pointer in the controller.

The interface in Fig. 3 is displayed at the time the player chooses the Start to Play Menu. 5 game levels can be selected in this educational game: *Pantai Palaeo* (Palaeo Beach) *Hutan Meso* (Meso Forest) *Hutan Neo* (Neo Forest), *Goa Chalco* (Chalco Cave), and *Goa Bronze* (Bronze Cave). In the new account, areas levels 2 to 5 are still locked, the player has to complete area level 1 to open the next areas. Here too is displayed the fastest time taken by the player that can be seen on the top left side in seconds. Every level has a reward for the player that has completed the area.

Fig. 3. The interface of selection of game level.

The player will get a reward for the opening of the mini museum room for area level 2 like in Fig. 4, and for level 5 the player will get a reward in the form of a sword that can be used in the game.

Fig. 4. The interface of the mini museum room.

The mini museum room in Fig. 4 is a room located in front of the main menu. This room houses prehistoric objects that have been found by the player during the game. The player can see again the descriptions of the prehistoric objects by pushing the button Trigger in the controller in the name of the 3D objects of the prehistoric objects. The interface of *Pantai Palaeo* (Palaeo Beach) is displayed after the user chooses *Pantai Plalaeo* in the menu of the selection of game levels. There are 4 prehistoric objects in the box in the location, one of them can be opened directly. While the rest can only be opened after the player finds the key to the box with the same color. The display after exploring prehistoric objects in the mini museum showed more details in Fig. 5.

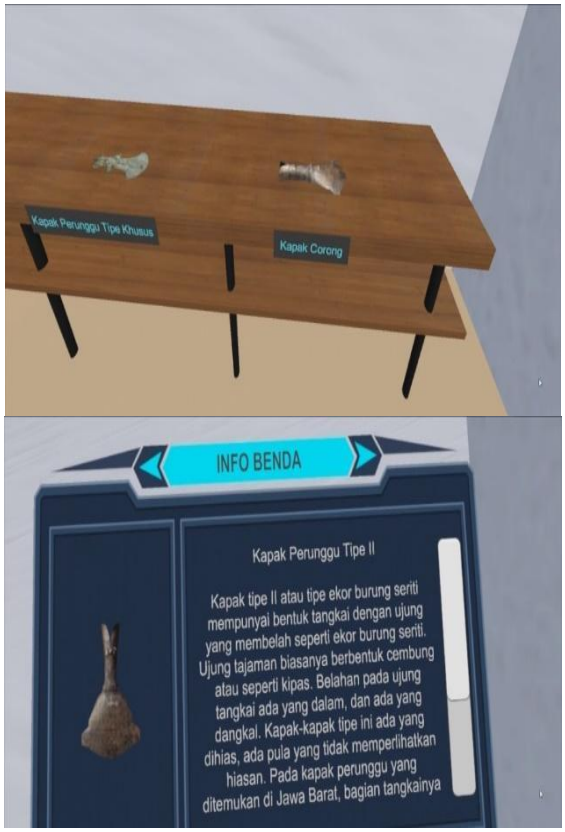

Fig. 5. The display after exploring prehistoric objects in the mini museum.

A. *Rules of the Game*

There are some game rules that have to be followed by the player. The rules of the game "*Penjelajah*" are as follows" a) the player has to complete area 1 to be able to play area 2, the same applies to the next area, etc. up to area 5; b) the player has to complete area 2 to be able to access the mini museum room; c) the player has to obtain the key first to be able to open the hidden treasure box; d) the enemy will attack the player if he or she stays near the enemy; e) the player will get injured when attacked by the enemy; f) the injury on the player will be cured gradually if he or she is not attacked by the enemy; g) the player will die if seriously be injured; and h) the player will come back to the main menu if he or she dies.

The condition of winning is if the player has collected all the prehistoric objects available in the game area. On the contrary, the failure condition is if the player is seriously injured at the time, he or she is attacked by the enemy several times. The game that has been developed is a game of adventurer in which the player goes around in the game area to look for and collect prehistoric objects around the area. Each prehistoric object is stored in a hidden treasure box. The box in white color is the box that can be directly opened while the ones with other colors are locked boxes and can only be opened after the player get the key whose color matches the color of the box. The same is true for prehistoric objects, the key can be obtained by looking for them in the

game area. If the player has collected all the prehistoric objects that are available in the area, he or she wins at the game level and then the time taken in the game and the reward obtained will be displayed.

B. Implementation in the Gamification

The game that has been designed consists of five levels. The description of each level is as follows.

1) Level 1 score improvementaeo (Palaeo Beach)

This area of the game is a beach area of a small island with big boulders and a cape. 4 prehistoric objects are distributed there: Square Adze, (the white box), Arrow (the black box), Stone Necklace (the dark green box), and Earthen Ware Vessel (the blue box). There are 2 keys in the hands of an enemy. In addition to the prehistoric objects and the keys, 4 tigers play the role of enemies and attack the player if he or she is close to them. The reward that can be obtained from completing level 1 is the opening of area level 2.

2) Level 2 is called Hutan Meso (Meso Forest)

This area is a forest with some big riverbanks that surround this area. 4 prehistoric objects are distributed here: *Nekara Moko* (Kettledrum) (a dark brown box), a type II Bronze Axe (a white box), and Special Bronze Axe (a light blue box). There are 2 keys on the wooden beam that are around the game area and 1 key in the hands of one of the enemies. In addition to the prehistoric objects and the keys, 5 tigers play the role of enemies and attack the player if he or she is close to them. The reward that is obtained for having completed level 2 is the opening of area level 3 of the mini museum j which can be accessed in the main menu. The player can see again the prehistoric objects that have been collected in the game and their descriptions.

3) Level 3 is called Hutan Neo (Neo Forest)

This game area is a forest with some big riverbanks surrounding the area. 4 prehistoric objects are distributed here: Bronze Vessel (the dark blue box), Bronze Axe (the white box), Shell Beads (the orange box), and *Kapak Candrasa* (Candrasa Axe) (the grey box). There are 2 keys on a wooden beam and 1 key in the hands of an enemy. In addition, to the prehistoric objects and the key, 6 tigers play the role of enemies and attack the player if he or she is close to them. The reward obtained for having completed level 3 is the opening of area level 4.

4) Level 4 is called Goa Chalco (Chalco Cave)

This game area is a cave with rock walls. 2 prehistoric objects are distributed in this area: *Kapak Candrasa* (Candrasa Axe) (the pink box), and *Kapak Perunggu* Type Corong (a Funnel Type Bronze Axe) (the purple box). There is 1 key on a stone in the game area and another key in the hands of an enemy. In addition to the prehistoric objects and the keys, 3 skull troops play the role of enemies and attack the player if he or she is close to them. The reward obtained after having completed level 4 is the opening of area level 5.

5) Level 5 is called Goa Bronze (Bronze Cave)

This game area is a cave with rock walls and some branches. 3 prehistoric objects are distributed in this area: *Nekara Heger* (Heger Steel Drum) (the light green box), Nekara *Pejeng* (Pejeng Steel Drum) (the brown box), Bronze Statue) (the red box). There are 2 keys on a stone around the game area and 1 key in the hands of an enemy. In addition to the prehistoric objects and the key, 3 skull troops play the role of enemies and attack the player if he or she is close to them. The reward obtained for having completed level 5 is a new weapon, that is a sword. The player can exchange the weapon for a bow in the game.

The result of testing is as shown in Table I, showing that all items of source code tested have been successful and followed the normal flow.

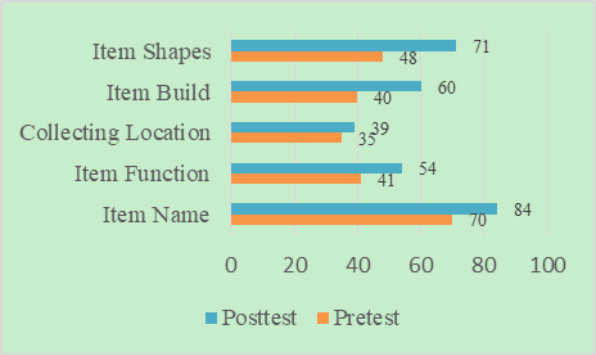

Fig. 6. Graphs showing the comparison of scores of the pre-test and the post-test.

TABLE I: RECAPITULATION OF USER RESPONSE QUESTIONNAIRE RESULTS

Num.	Statement item	Score	%	Category
1.	The difficulty level of the game is very difficult	15	75	Good
2.	The difficulty level of the game is very easy	15	75	Good
3.	I want to exceed the fastest time in the game	20	100	Very Good
4.	I can see the forms of prehistoric objects in the game	20	100	Very Good
5.	I can see the names of prehistoric objects	20	100	Very Good
6.	I can see descriptions of prehistoric objects in the game	20	100	Very Good
7.	I don't like playing educational games	18	90	Very Good
8.	I feel satisfied when completing the game with the fastest time	20	100	Very Good
9.	I like to learn something through games	18	90	Very Good
10.	I am hard to know the names of prehistoric objects in the game	20	100	Very Good
11.	I was troubled by reading descriptions of prehistoric objects	16	80	Good
	Total	202	1010	Very Good
	Average	18.36	**91.81**	

The result of the pre-test and post-test analysis shows that the average percentage of the score improvement was 31.62% from 58.5 to 77 (Fig. 6). Then, obtaining N-Gain or Normalized Gain score to find out the level of improvement in the post-test result, and the N-Gain score obtained was 0.80 so that the level of improvement in the result of the post-test falls into a high criterion [28, 34]. Then the testing of the response of the users yielded 91.81% as shown in Table I or the recapitulation of the User Response questionnaire results.

The average of 91.81% could be categorized as a very

positive and qualitatively the findings are as follows.

1) The application can provide an authentic context that reflects the knowledge used in the real life through the information about prehistoric objects described in gamification and is valued as very interesting and useful so that it can motivate the students as the users in learning. Gamification can unravel a person's motivation so that there is a significant increase in motivation [35]. Gamification can increase the ability of extrinsic motivation [16, 36]. Gamification can increase the need for satisfaction in learning and a feeling of fun in learning.
2) The application can provide a real learning activity since it can help the users to understand how prehistoric objects were found, who the ones who found them were, and where they were found. Augmented reality is applied in historical learning to improve the cognitive knowledge of learners [30]. This is because the historical lessons have learning characteristics that understand historical objects that can't be seen directly so that with augmented reality learners can see in real the historical objects [35].
3) The application can provide dual roles and perspectives. It can be used by users easily and it is relevant to school and college students. Gamification can simplify the learning process [28, 37, 38]. The ease of use of apps and how you use the Gamification app make learning more engaging and increase comprehension learning. This can facilitate the delivery of lesson materials in the learning process.
4) The application can support collaborative knowledge. The users or the general public become interested to try all the features that are available in the application and are enthusiastic to know prehistoric objects that exist in Indonesia. Gamification when applied in a collaborative and competitive learning model can foster collaborative ability among learners [16, 29, 39]. This has an impact on improving the learning process.

The people can create their own virtual worlds by utilizing the metaverse, a digital environment. Users from all around the world can connect there in a way that is more human than with other platforms. Students and teachers can connect in the metaverse regardless of where they are in real life by donning virtual reality headsets and meeting there. For individuals who are prepared to seek it out, such functionality can result in improved education. Instead of having students read from a book, teachers can create virtual environments based on their lesson plans, boosting students' learning. Learning how to use virtual reality in the classroom has many advantages over traditional teaching methods, like letting students undertake risky experiments in a secure setting or "visit" historical locations. Learning how the metaverse can benefit students and teachers demonstrates the advantages of metaverse education over conventional schooling, but there are also drawbacks to take into account.

V. Conclusion

Gamification can improve data in quantity and quality, provide more information about the student learning process to the learning process results. These learning outcomes have an impact on increased motivation and engagement, learning achievements, and social interaction. Digital gamification technology greatly influences the learning process in the field of content related to pre-history, a field that often makes students bored and has difficulty understanding concepts. In addition, teachers can teach the students by using gamification in the learning process.

The application of Gamification and virtual reality is very effective in enhancing motivation to learn and can engage the students in the learning process. This is shown by the change in behavior and attitude as well as the response of the students who were given a limited try-out in learning. Virtual Reality can be a forerunner to the creation of prehistoric tools into a new world in the metaverse.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

In this article, each author contributed to the completion of this article, namely, Agustini, K. conduct research and write draft articles; I.M. Putrama helped conduct research focused on virtual reality technology; D.S. Wahyuni conducted data analysis and I.N.E. Mertayasa helps in proofreading and provides additional studies related to the metaverse.

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