Design and evaluation on the immersive Virtual Reality system in learning archeology

F A Purnomo, E H Pratisto, F S Bahtiar, B K Riasti, L Puspitasari, N Ardhiana
Informatics Engineering Department, Sebelas Maret University, Jl. Ir. Sutami 36A Kentingan Jebres Surakarta 57126, INDONESIA
E-mail: fendi_aji@mipa.uns.ac.id

Abstract. This research aims to design and evaluate the three-dimensional Virtual Reality game at showroom 1 and 2 of the Sangiran Museum. This application is designed for the media campaign and increase the appeal of the public to educational tourism contained in Sragen regency, the location of the museum. The game genre is quiz with scoring and it allows the user to guess the fossil name that is displayed on the screen. Twenty visitors were participated to evaluate the application after they finished exploring both showrooms. Questionnaire is used to measure the use of the application. The result shows good acceptance in term of usability. It is expected that visitors can add educational value to their knowledge on the post-visit to the museum.

1. Introduction
Sangiran Museum has been designated as one of the World Heritage by UNESCO on December 6, 1996. Sangiran Museum is an educational place and is often visited by visitors both inside and outside the city. Sangiran Museum, especially in Krikilan, keeps the largest collection of ancient objects compared to the Ancient Museum in the vicinity. However, based on the observation of many of these visitors, they forgot and did not even know what the names of fossils were in the showroom. This is because most of the visitors just look at the fossils and or take pictures near the fossils. From these problems, the value of education from the museum was not right on target.

Based on research by [1], stated that the technology-based interactive entertainment experience is offered by the museum to keep visitors interested and entertained. Several applications have been developed that help visitors when visiting a museum. Like a visitor assistant application called iMuse developed with the mobile UHF RFID Reader [2]. Even to find out the knowledge of visitors [3] has proven through virtual museum games regarding fossil age simulation, that the user's knowledge has improved after the pretest and posttest were performed. Serious Games applications have also been developed [4][5][6,7] and analyzed [8] through the creation of accurate 3D models of cultural heritage presented in fully immersive virtual and interactive environments. This research will make and evaluate the results of the making of Serious Games (SG) regarding the introduction of cultural heritage (CH), namely the introduction of the names of ancient fossils at the Sangiran Museum. Regards this case, Virtual Museum can also be used for preparation of actual museum visits, or after a visit for the purpose of debriefing in the formal learning setting framework [1].
2. Experimental
There are several stages in making Serious Games Introduction to fossils in users. The application is made using Unity Games 3D, modeling 3D fossils made using Blender. Name The fossil object was obtained at the Sangiran Museum in showroom 1 and showroom 2, each of which took 10 fossil objects so that there were a total of 20 fossil object introductions. Tests were carried out on various devices and questionnaire forms regarding the usefulness of the Serious Games application that was created. The research stages are presented in Figure 1 and modeling 3D fossils in Figure 2.

![Figure 1](image1.png)

**Figure 1.** The making of Serious Games is the introduction of fossil objects

![Figure 2](image2.png)

**Figure 2.** 3D The fossil reconstruction model (right) is almost equal to the original (left)

Interactive buttons on games are performed by the cursor head. So to choose navigation is done by moving the player's head and the help of the gyroscop sensor embedded in the device. So the selection of navigation buttons is done by positioning the cursor for 2 seconds. Games play in Serious Games fossil recognition is presented in the order in Figure 3.

![Figure 3](image3.png)

**Figure 3.** Games play on the Serious Games for fossil recognition

3. Results and Discussion
The making of Serious Games is shown in Figure 4, starting with the spalsh screen, the main menu, the guide menu, the fossil view menu, the play menu, the results if the answers are right and wrong and the game summary results.
Figure 4. Serious Games display results about fossil education at the Sangiran Museum

The concept of Serious Game, Virtual Reality Technology in playing the Fossil Guess Sangiran Museum is made based on Android, which is a visual game application with interactive objects in the form of fossils in showrooms 1 and 2 which are presented in an environment of desert and forest. Besides that, there are also some information related to the explanation of existing fossils. The application is run with the help of VR Box and Bluetooth joystick to explore. This application complements the results of the manufacture [6,7] in presenting fossil learning in the Sangiran museum. The feature added in this study was that visitors were tested to recognize the name of the fossil in the exhibition hall of the Sangiran cluster in Krikilan.

Testing of 4 devices is done with different processor and GPU specifications but the same RAM memory is 3 GB. The results show the larger the processor clock, the application installation process and game games can run smoothly, which is 40% faster. The test summary is shown in Table 1.

Serious Games Testing about fossil education on users is carried out on 20 respondents on aspects of use, aspects of exploration experience, aspects of information delivery and aspects of goodness of fossil 3D models. Assessments made through a Likert scale strongly agree, agree, simply agree, disagree and disagree. The results of the questionnaire stated that the application was easy to use (strongly agree and agree 17.5% & 55%), players found new experience in recognizing ancient objects at the Sangiran Museum (strongly agree and agree worth 20% & 57.5%), information on introduction of ancient objects/fossils done well (strongly agree and agree worth 15% & 55%) and the results of the reconstruction of 3D fossil models are done to resemble the original form (strongly agree and agree worth 21.6% & 43.3%)
### Table 1. Test results on android devices

| No | Devices | Can play | Duration of opening the application (Seconds) | Gyro sensor | Information                  |
|----|---------|----------|---------------------------------------------|-------------|-------------------------------|
| 1  | Samsung J5 Pro (Process Octa-Core 1.6 GHz, Mali T-830MP2 GPU, 3 GB RAM) Asus Zenfone Max Pro (Qualcomm Snapdragon 660 1.80 Hz, Adreno 512 GPU, 3 GB RAM) | Yes | 3 | Yes | The application can run smoothly |
| 2  | Asus Zenfone Max Pro (Qualcomm MSM8937 Snapdragon 430, Adreno 505 GPU, 3 GB RAM) Xiaomi Redmi 3 Prime (Qualcomm Snapdragon 660 1.80 Hz, Adreno 512 GPU, 3 GB RAM) | Yes | 3 | Yes | The application can run smoothly |
| 3  | Asus Zenfone Selfie (Qualcomm MSM8939 Snapdragon 615, Adreno 405 GPU, 3 GB RAM) | Yes | 5 | Yes | The application can run smoothly |
| 4  | Asus Zenfone Selfie (Qualcomm MSM8939 Snapdragon 615, Adreno 405 GPU, 3 GB RAM) | Yes | 8 | Yes | The application can run but is slow |

The application tested in Table 1 is an android application with a file size of 307 MB.

### 4. Conclusion

Research results in the making of Serious Games for fossil recognition at Sangiran Museum have been successfully created. The evaluation results state that devices that can run applications properly have a 1.2 GHz processor clock with 3 GB RAM. The results after playing the game, visitors are interested in studying fossils or ancient objects at the Sangiran Museum through this Serious Games which are presented with Virtual Reality technology. Serious Games about fossil education can be used as an education for users who will visit or after visiting Sangiran Museum.

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