



# **Trials of the Acropolis: Teaching Greek Mythology Using Virtual Reality and Game Based Learning**

Pantelis Chintiadis<sup>1</sup>, Ioannis Kazanidis<sup>2</sup>(✉), and Avgoustos Tsinakos<sup>2</sup>

<sup>1</sup> Computer and Informatics Engineering Department,  
Eastern Macedonia and Thrace Institute of Technology,  
Agios Loukas, Kavala, Greece  
pantchin@teiemt.gr

<sup>2</sup> Advanced Educational Technologies and Mobile Applications Lab,  
Eastern Macedonia and Thrace Institute of Technology,  
Agios Loukas, Kavala, Greece  
{kazanidis, tsinakos}@teiemt.gr

**Abstract.** The evolution of learning environments is huge in recent years in the fields of mobile, blended learning and telecommunication technologies. Many courses are using VR tools to recreate historic and natural sites, while teachers use VR, guiding students to never before seen historic places.

This paper presents a VR game for the instruction of the 3<sup>rd</sup> grade Greek history, and in particular the Greek mythology. The main objective of this paper is a brief description of the technologies used, the design and implementation procedure, the presentation of the adopted educational scenario and the preliminary results of formative evaluation.

**Keywords:** Virtual reality · Mobile learning · Game based learning  
Greek mythology · Primary education

## **1 Introduction**

Mobile devices and technologies are evolving at frenzy rates, enhancing our access to every part of the surrounding world. New ways to learn, interact, publish and explore our everyday living, have been invented and established already.

Virtual Reality (VR) stands among these technologies that thrive in nowadays, causing a paradigm shift in human machine interaction field. Since the 1950s virtual reality has been hovering through the noir themed streets, struggling to be the biggest invention the world has ever seen, but at some pointed failed to achieve commercial adoption. Fast forward today reports say that until 2019 VR will grow to \$15.9 billion industry [1]. With this powerful new technology, learning and entertainment can be experienced from a different angle and can help all levels of education sector guide students to new pools of information.

With so much attention in the last few years for virtual reality, the developers have been constantly thinking new ways to discover uses of this promising technology in our world. Today VR applications are very diverse, however they serve the same goal

which apparently is life-long learning. Some of the most popular applications categories are outlined below [2, 3]:

### **Scientific and Architectural data visualization**

Medicine engineering and scientific fields year by year try to expand and the push their boundaries in order to make the human world better. Using appropriate input devices like data gloves and head mounted displays, scientists and engineers can create and prototype whatever new technology they design and test it in a virtual environment. On the architectural side historians and archaeologists can make their imaginations reality, by walking and interacting in long lost ruins and temples of the ancient world.

### **Simulation and Training**

One of the most common simulation targets is the training category. Establishing a safe virtual world, that can emulate a real and dangerous environment, can be a pretty big plus for training organizations or companies that wish to give their employees more experience in real world situations. Vehicle simulation, battlefield visualization, flight simulation and medical procedures [4] are some of the categories that benefit using virtual reality equipment and suitable software.

### **Entertainment**

The most expansive and ever growing area that takes advantage of VR is entertainment. From videogames, to movies and videos, users have a plethora of choices to select and entertain themselves. All kinds of videogame genres are available for every kind of customer and their graphics are constantly getting better and better, with wand-like devices and different platforms the diversity is huge.

Virtual reality's hardware is mainly split into two main categories: Tethered and Mobile. Tethered like the Oculus Rift, Playstation VR, and HTC Vive are connected with a PC, except PS VR which connects with a Playstation 4. The headset has a built-in LCD display, motion sensors, a camera tracker and with a combination of a powerful desktop computer capable of running virtual reality apps the immersion is huge [5]. Mobile headsets like Google Daydream and Gear VR on the other hand are shells with lenses, where a smartphone is placed. These kind of devices can be used anywhere since there is no need for a cable or PCs. However, since all the processing is done by the phone, mobile headsets suffer on performance in comparison with tethered devices.

In this paper we are going to explain the followed process, the tools used to develop the proposed educational VR videogame, the adopted game theory and introduce the main game scenario and game environment.

The main objective of this paper is to present the approach we followed and the developed VR game which aims to help the students of the 3rd grade, and anyone who wants to learn and play simultaneously, learn about the ancient Greek myths and tails with an immersive learning experience. To achieve this goal we developed Trials of the Acropolis a VR game that takes place in Ancient Greece and tells its own story, using a collection of myths that are included in the History book of the 3<sup>rd</sup> grade.

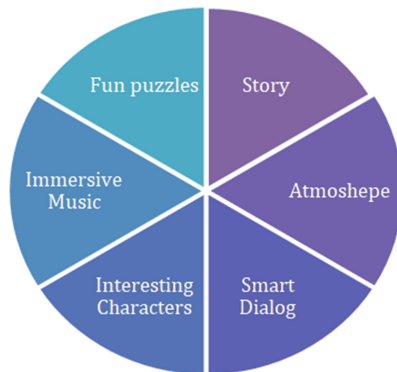
## 2 VR in Education

Research has shown that the average person only remembers 20% of what they hear and 30% of what they see, but up to 90% of what they personally experience [6]. As a result, VR educational materials provide the scenario needed to build the attention gap, helping students to become more attentive during lessons. A meta-analysis on K-12 and higher education students has concluded that students learn better when immersed in virtual worlds [7]. Another analysis [8] of 54 studies on the use of VR in education, has discovered that user engagement and participation in VR worlds is contributing positively to learners achievements.

There is a broad range of VR apps and games developed with the education element in mind and the majority of them are completely free. Acropolis VR 3D [9] is a great example of such an app, available for a lot of different languages. Developed by Mozaik education and available for Google Cardboard, this educational app introduces Acropolis of Athens with a lot of history information and some quiz games. It's an architecture walkthrough where the user can walk in all of Acropolis in VR mode and when disabling this mode s/he can play a mini quiz game and read some actual facts. A similar VR approach is the Acropolis experience [10] available from the Unimersiv app for Gear VR devices, Google Cardboard and other VR devices. It has slightly better graphics in comparison with the Acropolis VR 3D and has a guide tour, where there is an autowalk script along with a narrated voice presenting the history of Acropolis, and a free tour where the user can walk across the environment.

## 3 The Case of Trials of the Acropolis

Trials of the Acropolis provides a game based learning approach to give education more ways to distribute knowledge. It offers puzzle solving quests, multiple choice quiz games, interaction with the game characters (heroes from the Greek mythology), provided in English and Greek audio, immersive original soundtrack and background music, and a unique story ready to be explored. The key element features of the produced game are presented in Fig. 1.

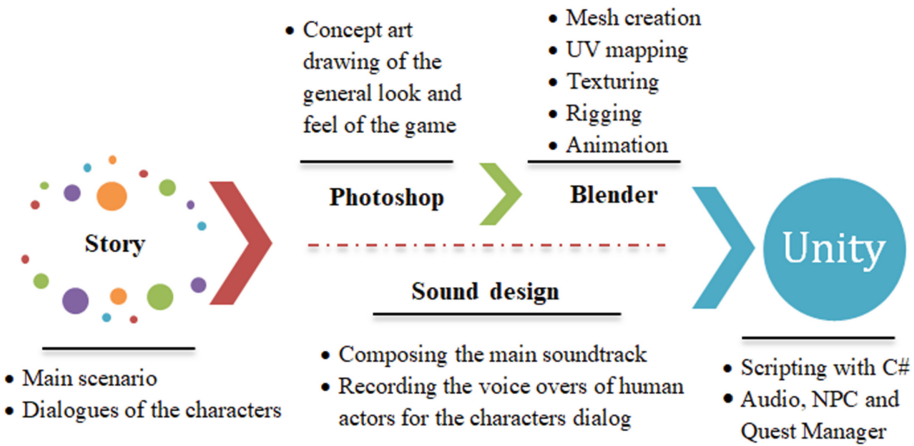


**Fig. 1.** Diagram showing the primary elements that Trials of the Acropolis is focused

Storytelling is a characteristic that a lot of games ignore and instead emphasize on gameplay. However, a good narration, great atmosphere and a mystery element raise the overall quality of a title and guarantee better interest levels [11]. Creating believable characters with interesting personalities and explaining their motives and their real world problems, makes the player more immersed in the story, rather than the gameplay.

Game like activities have positive impact on students motivation, engagement and performance [12–15] triggering also, as a side effect, other skills such as imagination, storytelling, challenge and cooperation. These characteristics are in line with the Constructivist theory where fun, enjoyment and reward are essential pieces for the students’ motivation [16].

Figure 2 depicts the approach for the game development, where at the first step the story, the game scenario and the dialogues of the characters are prepared. At a second step, the graphics and the sound of the game have to be implemented. Finally all the assets of the game are composed using Unity 3D game engine. The game was designed for Google Cardboard and Samsung Gear VR.



**Fig. 2.** Diagram of the adopted design and development of Trials of the Acropolis

A detailed analysis of these steps is described in the next sections.

### 3.1 Game Scenario

Trials of the Acropolis uses a game scenario where it challenges the player to fulfill an ancient myth, which no one in the history of Ancient Greece has ever completed. According to the myth there are scattered six trials, across the Acropolis of Athens, that test the wisdom, memory and concentration of a human. These ancient trials – myths were created by the gods themselves and the person who will complete all the trials with success, will emerge as the true leader of Ancient Greece and help the country during the difficult times she is facing. Each of the first 5 ancient trials-myths of the game, is based on a corresponding chapter of the 3<sup>rd</sup> Grade history book of Greece and involves two phases, as presented in Table 1.

**Table 1.** Trials characteristics

No	Trial name	Subject	Phase 1	Phase 2	Book section
1	A new hope	Gods and Titans	Puzzle	Quiz	1
2	Rise of the hero	Hercules	Puzzle	Quiz	2
3	Labyrinth madness	Theseus	Puzzle	Quiz	3
4	The mythic treasure	Jason and the Argonauts	Puzzle	Quiz	4
5	A melody from the stars	Odyssey	Music game	Quiz	6
6	The olympian wisdom	Revision of the above	Puzzle	Quiz	–

When the game initiates, the player is placed at the entrance of Propylaea, visiting the Acropolis for the first time and without knowing anything about the myth which will be confronted. The player is supposed to interact with the avatar/game narrator, sitting at the stairs and looking very disappointed (Fig. 3). When the player approaches, the narrator provides some input to the player, explaining that he has travelled a long way to come here and complete the trials/myths, in order to gain wealth and build a better future for his family. Though, despite his efforts, he failed to complete his task and therefore he is preparing himself emotionally, for the long way back to home. The narrator provides further information to the player related to the myth, on how the gods fought the titans, the general structure of the Olympic pantheon and how the trials were formed. He encourages the player to try and solve the trials and wishes him luck.



**Fig. 3.** A concept art depicting Propylaea with the wandering stranger just before the assignment of the first task.

Once, the introductory part is complete, the game starts, and the movement across the environment of Acropolis is done with predefined waypoints, guiding the player to the right destination. The first trial and generally all the trials consist of two phases: the puzzle phase and the quiz game phase.

After the first trial the player meets Megara the wife of Hercules. She tells the myth of how her husband was born, and a background of some of the labors he pursued, while also giving directions for the second trial.

The third trial is given by Theseus the legendary hero who killed the Minotaur. As all the NPC's (Non playable characters) of the game tell a different myth so does Theseus, giving the player important details of information about his past adventures. Theseus further explains that he didn't want to participate in these trials, because his name has already been written in the history and it would be better for the new generation getting more confidence and experience by pursuing such challenges.

By successfully completing the third trial, the player needs to speak with the Temple Guardian of the Parthenon. His family and ancestors were guarding the temple for centuries, passing the torch to their strong children. When he was a little kid, temple guardian met Jason in Iolkos during a trip with his family. Jason knew that the guardians of Parthenon were very respectful and strong people, so he gave them a single golden hair from the legendary Golden Fleece as an act of honor. For that reason, the guardian tells the story of Jason and the Argonauts and also pointing that the fourth trial is located inside the Parthenon but warns the player, Acropolis is going to close so he has to hurry.

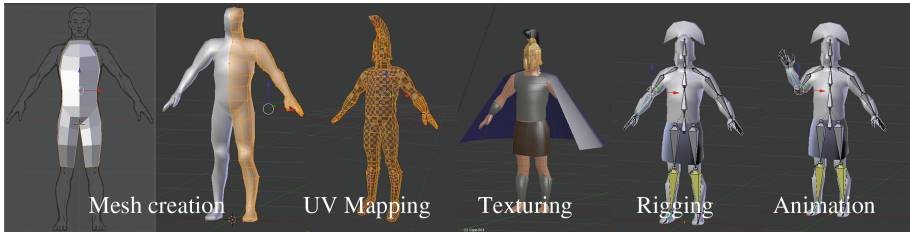
The penultimate trial is given by Orpheus near the Erechtheion. The part of story that Orpheus narrates, is based on the Odyssey and in particular, how the cunning Odysseus returned back to Ithaca. Only a small portion of people have come so far to complete the fifth trial, but all have failed. This trial has a different type of first phase. The player has to solve a memory game where Orpheus plays some melodies with his harp, which corresponds to specific buttons that are shown on screen. The player will then have to remember the pattern and press the buttons in the right order, so as to accomplish this part of the trial and proceed to the quiz phase.

The final trial, takes place in front of Zeus temple, behind the Parthenon. The player so far has collected all the five stones from the five trials and he has to place them in the correct order in front of the temple to invoke Zeus himself. Zeus is heard talking from the skies, but he cannot be seen. Zeus congratulates the player for making it this far, but warning him that he has to complete eight difficult questions in order to fulfill the myth. Completing correctly all the questions, the player emerges as the true leader of Greece and finishing the Trials of the Acropolis videogame.

### 3.2 Implementation

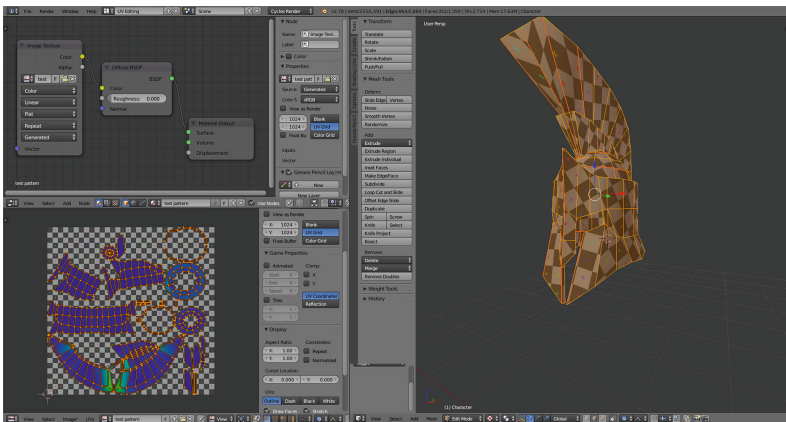
For the development of Trials of the Acropolis, mostly, free professional game development tools was used. Software like Autodesk 3ds Max, Maya, Cinema 4D are the top software for professional production, however, Blender 3d does almost the same job and its totally free. Similar at the game engine selection, we were pretty much close to choose the Unreal Engine 4, however, at the end, Unity was chosen since it offered a very flexible development process and a large community supporting, with a wide range of video tutorials and books. Therefore the primary tools used for the game development were Adobe Photoshop, Blender 3D [17] modelling software, Unity [18] game engine and Reaper [19] digital audio workstation.

Blender is free modelling software that packs all the essential tools needed for professional game model production, at zero cost. All the model meshes, textures, rigs and animations were done in Blender 3D. Blender is packed with intuitive functions like the modifiers category, where every single modifier does a useful and time saving task. For example the array modifier, can make copies of the selected object and by incrementing a particular value of the x, y and z axis the objects copies are placed along the selected axis. The array modifier was used on Trials of the Acropolis, during the modelling process of the temple columns, and saved a lot of development time. The characters models during the applied processing steps in Blender are presented in Fig. 4.



**Fig. 4.** Various models of game characters during the Blender processing steps

During the development of the objects meshes, the most common used functions were “loop cut and slide”, subdivide, and extrude. Loop cut splits a loop of faces by inserting a new edge loop, intersecting the chosen edge. Subdividing splits selected edges and faces, by cutting them in half and finally extrusion tools duplicate vertices, while keeping the new geometry connected with the original vertices. Vertices are turned into edges and edges will form faces. After creating the model meshes, UV mapping takes place. UV is the 3D modeling process of projecting a 2D image to a 3D model’s surface, for texture mapping. By selecting the mesh, pressing **Cntrl+E** and choosing mark seam, the selected area is cut, making the object flat and the mesh better for texturing (Fig. 5).



**Fig. 5.** UV mapping procedure of the Wandering stranger helmet.

After the UV mapping, the texture coloring is following. Blender has a lot of useful tools when coloring an object, like the fill function. For mobile VR games, taking into consideration the small screen size, and their processors it is proposed to decrease texture resolution.

When a character is fully textured, rigging process follows. At this stage the bones are inserted to the character. Rigging is necessary in order to animate the produced characters.

The final process of the character development cycle is the animation stage. Animation is making an object move or change shape over time and objects can be animated in many ways: (a) Moving as a whole object, changing parameters like position, orientation or scale in time, (b) Deforming objects, animating vertices, edges and faces and (c) Inherited animation, causing the object to move base on movements by another objects animation.

Completing all the games characters and the Acropolis environment, the objects are ready to be exported to Unity, using the fbx file format in the Blender export window.

The final stage of development is then passed to Unity game engine. Unity is an all-purpose game engine that supports 2D and 3D graphics, drag and drop functionality and scripting through C#. Unity today is the most used game engine making rapid prototypes of any videogame and speeding up the development process of all the computer game companies. At this development stage the quest, audio and NPC management takes place. All the scripting managers perform various tasks, like storing game data and audio initialization. Before the implementation of the game, some settings in the Unity interface needed to be adjusted, so as to have a steady 60 frames per second performance during the game, otherwise, the user will have motion sickness. Things like realistic shadows, ambient occlusion, real-time global illumination, are highly proposed to be disabled in order to achieve that.

### 3.3 Gameplay

One of the problems that every VR game has to deal with, is the user interaction with the game objects. We wanted to be able to play the game even with just the use of a smartphone and a Google Cardboard. Therefore the user interaction is based on mobile sensors instead of a joystick. Therefore we decided to allow user interact with the game objects, by looking at an object for three seconds. For example as we previously stated, traveling inside the game is accomplished with predefined waypoints. The player simply has to look at the next waypoint for three seconds and then a walk script initializes, moving the player to the marked destination. When a waypoint is reached, the player cannot go back to his previous destination. We made the decision to make a simple user interface, that the player can interact with all the game objects in the same way and avoid possible confusion.

NPC's interact with the player when s/he approaches their trigger zone, which is a collider that starts a specific function when the player object touches it. When the collider is touched, a specific NPC script is played starting the voiceovers and animations of the particular character (Fig. 6).





**Fig. 6.** Temple guardian in front of Parthenon during the 4th trial

### 3.4 Formative Evaluation and Preliminary Results

In order to proceed with the pilot use of the developed game, a formative evaluation with a small group of five teachers took place. The goal of the formative evaluation was to discover potential bugs of the game, to find out if the dialogues and game scenario is appropriate for the 3<sup>rd</sup> grade students (according to their teachers) and take a preliminary feedback about the perceived ease of use and usefulness of the game.

Our research preliminary results show that the five teachers that tested the game, were pretty satisfied and pointed out their strong believe that this game will help their students to experience the world of ancient Greece in a fun and educational way. The main observation that they made was about improving the length and context of the myths that the NPCs tell to the player. In addition they pointed some minor modifications on the dialogs and propose to be more concrete with the game objectives.

## 4 Discussion and Conclusion

The present study presented a VR game, along with the tools, techniques and the scenario which were used. The Trials of the Acropolis can contribute greatly to the school and education environment by providing an extra path, which uses the VR capabilities, supporting students and teachers. Our research concludes that game based learning applications, can be a useful tool for teachers and students, in this type of knowledge domain. It can greatly improve learning experience and help teachers engage their students during the course by planning which areas of the game they will discover for a particular lesson.

The preliminary results were very positive. However, there are some notable limitations that should be considered for the current research and especially the fact that no summative evaluation took place. The formative evaluation had a sample size of just five teachers and no students' opinion was discovered. However the main aim of the paper is to point the tools, the scenario and the idea behind the produced game.

It remains unclear how this game-based VR application can impact students' motivation and performance in the applied course. We are planning to use the Trials of the Acropolis during the next school year, in 3<sup>rd</sup> grade students, in order to confirm the preliminary results of this paper and study on its impact in student's motivation, engagement, satisfaction and performance.

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