REENACT: Augmented Reality and Collective Role Playing to Enhance the Pedagogy of Historical Events
An EXPERIMEDIA Experiment

Martín López-Nores, Yolanda Blanco-Fernández, José J. Pazos-Arias, Alberto Gil-Solla, Jorge García-Duque and Manuel Ramos-Cabrer

AtlantTIC Research Center for Information and Communication Technologies,
Department of Telematics Engineering, University of Vigo, Vigo, Spain

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Abstract: Much of human history has been shaped by the outcomes of countless battles and wars. Unfortunately, the classical pedagogy of these events merely tells about who were the belligerent forces, how long the fights lasted for, and who ended up winning. We present one proposal to engage groups of people into immersive collective experiences that will make them learn about a certain battle or war both from the inside, as reenactors, and from the outside, as historians. The participants will be equipped with smartphones or tablets that interact with the technological facility developed within the EXPERIMEDIA FP7 project, which provides support for the implementation, deployment and execution of distributed live games, social networking features and augmented reality.

1 INTRODUCTION

History is commonly taught in a way that major battles and wars are put down as occasional events that just happen, that involve two sides (often appearing as the good and the evil forces) and that apparently end fortuitously, as by tossing a coin. Nothing is that simple in reality, and so the classical pedagogical approach neglects many facts about the reasons for the battles, alliances and supporters, why things went on the way they did, what were the winning or losing choices, what were the consequences in the short, medium and long terms, etc. As a result, the general awareness of History in our society is rather partial and deficient.

Fortunately, novel technologies provide powerful means to make things better and more interesting. Smartphones and tablets have already been around for some time (Akkerman et al., 2009; Sala et al., 2011), just like social networking (Arends et al., 2012), videogames for learning (Charsky and Ressler, 2011; Watson et al., 2011) and even virtual reality (Jacobson et al., 2009). We present a new approach (called REENACT) that introduces augmented reality technologies in History learning. The aim is to engage groups of people into immersive collective experiences that will make them learn about the prelude, the course and the aftermath of battles and wars with the aid of tactile mobile devices, repositories of multimedia contents, an advanced technological facility and remote experts. Very briefly, the REENACT experiences will be organised in three stages:

- Stage 1 (reenactment) is about involving groups of people in the reenactment of battles. They will be moving around in a room, playing the actions defined for a given role by a script of the event and interacting with the other participants inside the game. Tactile mobile devices will provide the participants with an augmented reality vision resembling a multiplayer role-playing game.
- In stage 2 (replay), the participants will be taken to a projection room to analyse what has been happening. They have already lived the battle from inside, with a very partial vision, and now it is turn to learn more by watching things from outside, and to see how their recreation compares to the real historic events. The explanations will be given by one expert, who may be physically present at the projection room or appearing on the screen from a remote location.
- Finally, in stage 3 (debate), the expert will drive a collective brainstorming about the consequences of the conflict in the short, medium and long

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terms. The projection screen will become a dynamic big board to display comments posted by the participants, which can be rearranged by the expert as the debate goes on. At any time, the expert will be able to choose multimedia contents to illustrate the different points that are raised.

In this paper, we firstly present the details of the REENACT proposal (Section 2) and its implementation (Section 3). Then, we describe our experimentation plans (Section 4), taking a look at some of the indicators we will be measuring to assess the value of the proposal for different stakeholders, in terms of *Quality of Experience* (QoE) and *Quality of Community* (QoC). Conclusions are given in Section 5.

2 THE REENACT APPROACH

We will look into the three stages of the REENACT approach by borrowing examples from the specific scenario of the Battle of Thermopylae, which is the first event we will experiment with. This event is quite popular as a symbol of courage against overwhelming odds, but it is not really well understood due to non-rigorous treatment in movies and comics. Fortunately, the details reported by Herodotus (Herodotus (author) and A. D. Godley (translator), 1922) and other historians provide sufficient scenes to yield both a didactic and enlightening experience to explain such facts as the advantages of training, equipment and good use of terrain as force multipliers. These are some of the points to highlight during the experiences.

2.1 Details of the Reenactment Stage

Once a sufficient group of people has been formed to participate in a REENACT experience about a given battle or war, they will be taken to a room where they will first watch a brief projection explaining the historical context of the conflict. Then, they will be *armed* with their tactile mobile devices and assume a given role in the battle, fighting for whichever side.

The tactile mobile devices will be providing the participants with the actions they may make at any given moment: to advance on a certain stand, to retreat, to fight one way or another, to surrender or not, etc. The choice of possible actions will be a function of each individual's choices, the orders delivered by the respective commanders or decisions made collectively by voting. The options appear on the top half of the mobile devices' screens, along with links to pieces of content that explain the current state of things (see Fig. 1).

Some of the reenactors' actions will require them to move around the room, seeking different zones identified by 2D codes on the floor or on the walls. The mobile devices help identify the zones by augmenting the world seen through the cameras with representative 3D models, as shown in Fig. 2.

The zones correspond to locations that are displayed on the maps of the bottom half of the devices' screens (see Fig. 1). This way, each participant will be able to visualise his/her position in the scenario of the battle, where the rest of the people will be characterised as per their roles. In the case of the Battle of Thermopylae, the zones are arranged into three different scenes:

- The first scene (appearing on the left of Fig. 1) situates the main locations during the prelude of the battle: Asia Minor, the Hellespont, Thessaly, Phocis, Thebes, Corinth, Arcadia and Sparta.
- The second scene (appearing on the right of Fig. 1) displays the relevant locations during the course of the fights in the Thermopylae area: the Persian camp, the Greek camp, the old Phocian wall, the Anopaean path and the Greek rearguard. These locations can appear either on a satellite view of the area (as seen nowadays) or on an ancient historical map overlaid on it, which helps the user understand how the area has changed over the centuries due to a process of sedimentary deposition that has moved the coastline far apart from the mountains.
- The third scene displays three afterlife locations to host participants whose characters die during the reenactment: the Elysium (Greek heaven), the Tartarus (Greek underworld) and the Garothman (Zoroastrianism heaven).

Another feature of augmented reality to enhance the immersion is the provision of 360° views of some zones, including the Greek and Persian camps at Thermopylae. One snapshot of the former is shown in Fig. 3.

Augmented reality is also used when it comes to battling. One-on-one fights can be easily simulated by having two reenactors (one from each side) move 2D codes around the surface of a table, interpreting moves forward and backwards as attack and defense gestures, respectively. The screens will be displaying a fight between 3D models accordingly. Simple logical puzzles (adapted from Simon Tatham's collection[1]) will also be offered to fill dead times waiting for other reenactors' decisions or actions.

Finally, to enhance the feeling of a collective experience, one laptop can be put to use any big

[1] http://www.chiark.greenend.org.uk/~sgtatham/puzzles/

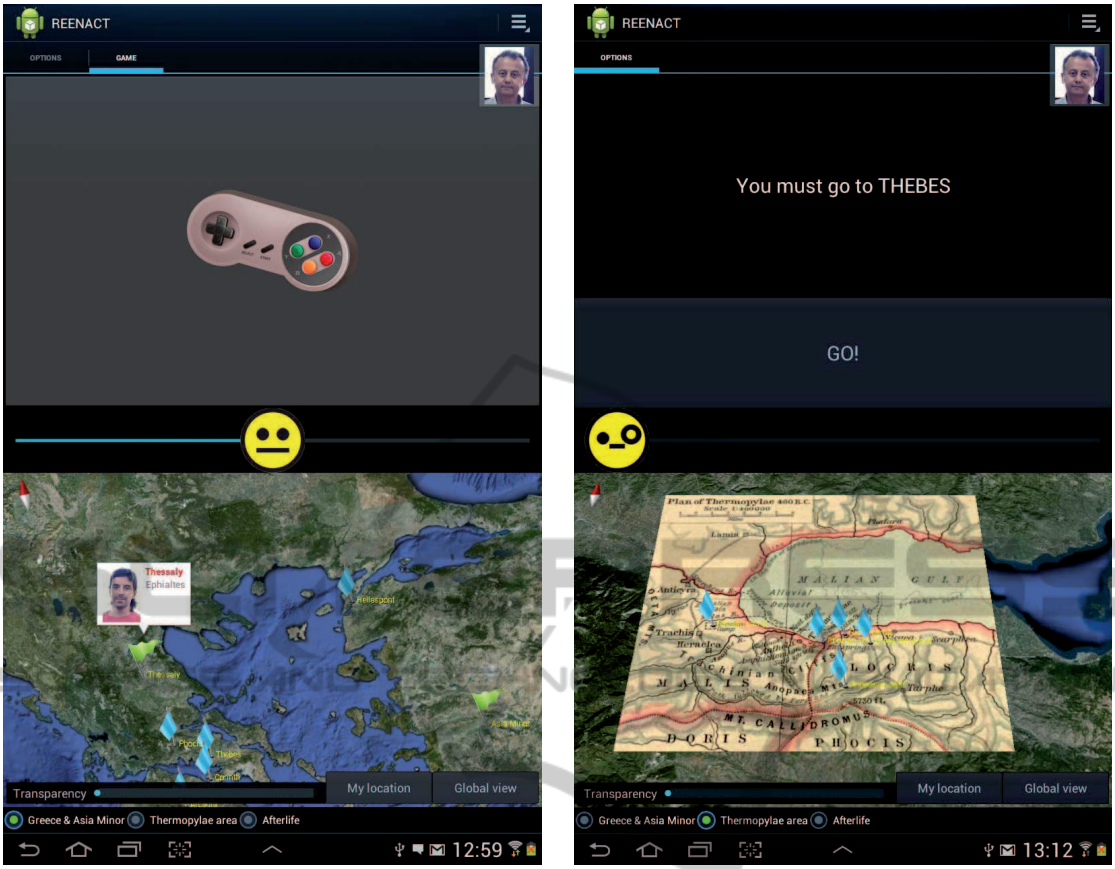

Figure 1: Snapshots of the main activity of the reenactors' application.

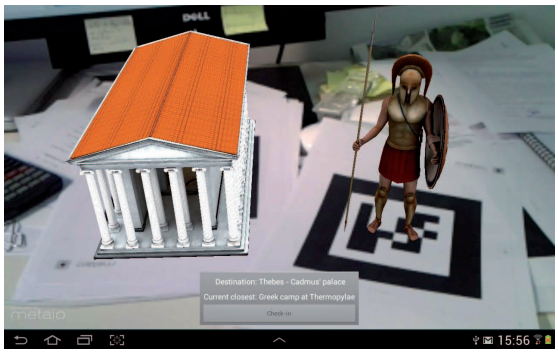

Figure 2: Displaying 3D models over 2D codes.

Figure 3: A 3D view of the Greek camp at Thermopylae.

screens or projection boards available in the reenactment room to display the visualisation of the scenario of the battle, along with video footage that may serve to illustrate what is going on, and even pictures or textual comments coming from the reenactors' devices. If available, loudspeakers will play accompaniment music and sound effects for further immersion. These features may enhance the educational aspect too, as proved in (Fassbender et al., 2012).

2.2 Details of the Replay Stage

Once the recreation of the battle has finished, the reenactors will be taken to a projection room to analyse what has been happening. They have already lived the battle from inside, with a very partial vision, and now it is turn to sit down and learn more by watching things from outside, to see how their recreation compares to the real historic events.

The second stage of the REENACT experiences

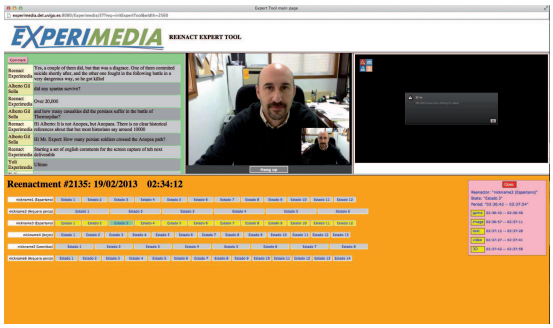

Figure 4: A snapshot of the expert's interface.

will be driven by one expert, who may be physically present at the projection room or appearing on the screen from a remote location. The expert will rely on a record of the movements and actions of each participant during the reenactment. Combining this record with the script of the battle, the expert will be able to identify specific situations lived by the reenactors that could serve to explain important facts about the course of the fights (e.g. to illustrate the technological superiority of one of the opponents, the war tactics employed, etc).

As it can be seen in Fig. 4, the expert's interfaces will show a timeline of what each one of the participants has done, decided and watched during the reenactment stage. The sequence of contents displayed on the big screens of the reenactment space will be displayed, too. This way, the expert will be able to choose the most suitable contents to support his/her explanations, which will be projected on the top half of the projection screen. Additionally, the bottom half will be displaying the video feed from the expert's webcam and some additional material, like a map of the battle with the avatars in place or textual comments typed by the reenactors.

The important point of the replay stage is to relate the reenactors' experiences with the historical facts, which should help them to realise and memorise facts that usually go unnoticed in traditional History teaching. Therefore, the expert must devote some time to explaining what aspects of the reenactment diverge from the real facts, either because the scripts make some allowances or because the participants have made the opposite of the real characters' decisions. Also, the expert may choose to run a collective quiz game with multiple-choice questions about the prelude and the course of the event. This may be a qualifying game (the one who misses an answer is eliminated) or a cumulative one (the one who gets the greatest number of correct answers, wins). Typically, there will be only one correct answer, while at least one other option could make sense and at least one would be ridiculous, like in the following example:

- *Who was the predecessor of Xerxes I?*
  1. *Xerxes 0. (FALSE)*
  2. *Darius the Great. (TRUE)*
  3. *Julius Caesar. (FALSE)*
  4. *Arnold the Great. (FALSE)*

There will also be questions in which all the answers are correct, just seeing one fact from different perspectives, like:

- *What was the year of the Battle of Thermopylae?*
  1. *The 4th year of the 74th Olympiad by the Attic calendar. (TRUE)*
  2. *Year 274* ab urbe condita. *(TRUE)*
  3. *Year 2157/2217 by the Chinese calendar. (TRUE)*
  4. *Year 23 by the Achaemenid calendar. (TRUE)*

Finally, there may be features for pure entertainment like awards to the best soldiers of each side, rankings of participants ordered by how long they have survived, galleries of user-generated pictures, etc.

2.3 Details of the Debate Stage

After the replay stage, also in the projection room, the expert will drive a collective brainstorming about the consequences of the conflict in the short, medium and long terms, wondering what might have been different in History if things had happened differently. For example, considering the Battle of Thermopylae (which was not really decisive) in the broader context of the Greco-Persian wars, the topics for debate will include the following:

- *Would there be fewer ruins in Athens today if King Leonidas had stopped the Persians' advance? Would the Parthenon ever have been built?*
- *Would the Persians have conquered the whole of Europe? If so, would all European countries be like Turkey today? Actually, would there be countries?*

- *Would the Persians have conquered a larger share of Africa, too?*
- *Who would have been the Persians' greatest rivals: the Macedons led by Alexander the Great the next century, the Carthaginians a little bit later, the Celts, the Vikings, ...?*
- *Would there have been Persian equivalents to Socrates, Plato and Aristotle?*
- *Would science have developed better or worse? Would the Middle Ages still have occurred?*
- *Would the Europeans have discovered America, or someone from America have crossed the Atlantic Ocean the other way before? If so, who?*
- *Would Iran have been a superpower as the USA are today?*

During the debate stage, the projection screen will become a dynamic big board to display comments posted by the participants, which can be rearranged by the expert as the debate goes on. At any time, the expert will be able to choose multimedia contents to illustrate the different points that are raised. Participants will type their comments using the tactile mobile devices, and, if chosen by the expert, they will have the possibility to explain their ideas or viewpoints to the whole audience in an audio- or video-call. Some arguments can be voted upon, or socially rated as "*possible*" or "*impossible*", "*likely*" or "*not likely*", "*interesting*", "*absurd*", "*original*", so that the most active participants get some kind of recognition. Again, there may be quiz games to appraise the participants' understanding of the importance and impact of the battle.

3 IMPLEMENTATION ON TOP OF THE EXPERIMEDIA FACILITY

The REENACT proposal has been implemented on top of the Future Media Internet (FMI) technological facility provided by the EXPERIMEDIA FP7 project[2]. As explained in (Salama et al., 2012), the technologies that reside in the EXPERIMEDIA facility have been encapsulated into four components under common type of content:

- The *Experiment Content Component* (ECC) monitors, derives experimental data from, and manages the other components, taking control of installation, deployment at the experimentation venues, running and termination. The ECC elicits *Quality of Service* (QoS), *Quality of Experience* (QoE) and *Quality of Community* (QoC) data from the other components and delivers it to the experimenters so they can analyse the behaviour of technical systems in relation to user experience.
- The *Social Content Component* (SCC) gathers and manages data that is generated on social networking sites during the course of an experiment. Internally, it provides access to different social networks (giving read access and publishing capabilities) and also communicates social network monitoring metrics to the ECC, which exposes it to the experimenters so that they can analyse and draw information from the social network activities that take place during the experiment.
- The *AudioVisual Content Component* (AVCC) provides services related to the management and delivery of audiovisual contents, including acquisition from a media producer, adaptation and distribution to different platforms, live edition and realisation, and data and metadata synchronization.
- The *Pervasive Content Component* (PCC) provides means to track the users' locations as a means by which augmented reality content can be delivered and user-generated data can be mapped to a spatial location. The PCC hosts an augmented reality platform and an online environment for the orchestration of distributed live games.

The REENACT experiences will be delivered by a software system comprising one server and three main interfaces: the reenactors' front-end, the expert's front-end and the administrator's front-end.

- The *REENACT server* centralises access to pre-recorded contents and live streaming through the AVCC, and to store the records of events raised during the reenactments. Besides, it provides a repository to store the static images and the text documents that may be used for illustration purposes at any time.
- The *reenactors' front-end* is an Android application that delivers the interactions envisaged for the participants, relying mainly on the PCC during the reenactment stage and on the SCC during replay and debate.
- The *expert's front-end* interacts mainly with the AVCC to allow the expert to join from a remote location and to browse the content repositories. It also interacts with the SCC to enable participation in debates with means to highlight key words, to rule out offensive comments or foul language, etc.

[2]http://www.experimedia.eu/

- Finally, the *administrator's front-end* is a web application that provides the interfaces needed to supervise the operation of the rest of the elements during the REENACT experiences, including manual control over the orchestration of events during the reenactment stage and the gathering of information for later evaluation in cooperation with the ECC.

The main functional blocks and features of the REENACT system (green) in combination with the EXPERIMEDIA facility (light blue) are depicted in Fig. 5. More detailed information can be found in (Salama et al., 2012) and (López-Nores et al., 2012).

It is worth noting that the tactile mobile devices of the reenactors may be Android smartphones or tablets, with screens between 5 and 8 inches — smaller ones would not fit the amount of information to display, and bigger ones would not be comfortable to move around during the reenactment. Additionally, to successfully use and run the AR features, they also need to have a rear camera, gyroscope, compass and other sensors, plus sufficient computing power and a recent version of the Android operating system.

4 EXPERIMENTATION PLAN

The scenario of the Battle of Thermopylae is being developed in collaboration with the Foundation of the Hellenic World (henceforth, FHW), a not-for-profit cultural institution based in Athens that boasts a unique technological infrastructure including the Tholos, a dome-shaped virtual reality (VR) theatre that delivers 3D contents rendered in real time. On the one hand, the FHW is providing support from expert historians to develop historically rigorous scripts for the reenactments and sets of questions and topics for replays and debates. On the other, their VR department are contributing 3D models for the AR features as well as some pictures and audio/video footage to put into the contents repositories.

The core of our experimentation will be done during the summer of 2013 in the Hellenic Cosmos (the venue provided by the FHW in Athens), but this will be supplemented with trials in the University of Vigo, both *ex ante* (to get early feedback and thereby fix defects in the software or in the experiment design itself) and *ex post* (to gather further evidence for the evaluation or to assess questions that remain unanswered). Due to EU privacy data protection policies, participants will be recruited from among the communities of students, professors, researchers and other staff of the University of Peloponnese and the University of Vigo.

During the experimentation sessions, the REENACT software will be feeding data into the ECC, that will be processed later to evaluate different parameters of QoS, QoE and QoC. QoS parameters include the following:

- CPU and memory consumption of the reenactors' app.
- Quality and latency of the pre-recorded videos delivered to the reenactors' app from the AVCC.
- Quality and latency of the video feeds transmitted by the AVCC from the expert to the projection screen.
- Battery consumption of the reenactors' devices. Data will be provided at the end of each stage by the app itself.

QoE data will include both quantitative and qualitative measures:

- On the one hand, the software will keep track of the movements and actions of the participants during the reenactments, and also of their interactions during the replay and debate stages. Likewise, the application will be providing stats about how and when the participants use its different features and interfaces.
- On the other hand, the mobile application will provide brief questionnaires to gather opinions about the REENACT approach and to rate different features of the experience: educational value, level of entertainment, convenience of the interfaces, quality and completeness of the contents, preferences for certain types of contents, etc. Those ratings will be matched against anonymous information about the participants' educational background and interest in specific topics.

Halfway between quantitative and qualitative, the voting and quiz games offered during the replay and debate stages will be used as sources of information about the participants' level of engagement and learning about the historical events. As a research question, it will be checked whether any of the aforementioned parameters depends on the roles played by the participants during the reenactment stage, since it might happen that the QoE measurements are better for someone who has played a main role (say, King Xerxes in the Battle of Thermopylae) than for someone who has played a secondary role (e.g. a Persian infantryman), or maybe that differences appear between winning and losing sides.

QoC measurements, again, may reflect both quantitative and qualitative aspects of the community of people that participate in a REENACT session. To

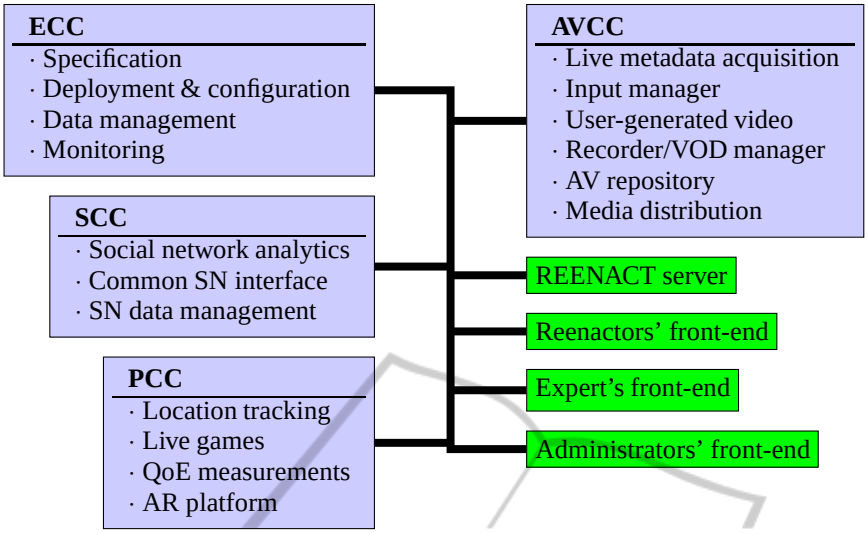

Figure 5: Main blocks and features of the REENACT system.

this aim, the experimenters will primarily look at the interactions among the participants during the replay and debate stages, e.g. counting the number of ratings and analyzing the length, mood and depth of the comments they exchange using their tactile mobile devices. Special attention will be paid to what happens among people who did not know each other before, for which they will all be asked to tick out the nicknames of their acquaintances right before starting the reenactment stage. Thus, it will be possible to address questions like whether strangers keep distances during the reenactment, whether they comment on the others' arguments, or whether there is any apparent bias in the ratings given to acquaintances and strangers.

5 CONCLUSIONS ABOUT VALUE IMPACT

Our experimentation is ultimately intended to assess the value impact of the REENACT proposal for entities like the Foundation of the Hellenic World, aiming to exploit the following facets:

- First-hand experimentation with an innovative FMI application that makes the most of possibly unused spaces, technological facilities, contents and personnel.
- Offering of a new kind of collective experience to reinforce the understanding of events that have shaped the history of a certain area of the world.
- New means for remote interaction with geographically-distributed actors towards the organisation of new exhibitions, projections of multimedia productions, collection of opinions about new contents and activities, etc.

Notwithstanding, we will try to assess whether the REENACT solution could be taken out of the museums, for example, to enable new pedagogical experiences in primary and secondary schools.

The data gathered about QoE and QoC will be used to assess the potential truth of the following claims for the different people involved in the experiences:

- Museum visitors or students will enjoy new edutainment experiences aimed at improving the understanding of historic events. They will have the opportunity of interacting with one another, and also with geographically distributed experts via user-friendly interfaces.
- Museum guides and educators will be able to participate in a new type of collective experience, supplementing the expertise and knowledge provided by the experts in replays and debates.
- Experts will be able to offer their services to collaborate with museum educators in new pedagogical experiences, interacting more closely than ever before with people interested in knowing more about major historical events. They will be able to efficiently browse repositories of multimedia contents to relate historical facts to specific situations raised during the reenactments, and to conduct live debates about the potential consequences of the fights in the short, medium and long terms.
- Content creators/providers will find an additional outlet for the multimedia contents they produce, which will be usable to provide historically-meaningful explanations to the situations arisen

during the reenactments and to the arguments raised during the debates.

- Last but not least, the experimenters (ourselves) will draw useful conclusions from metrics proposed to assess QoE and QoC from the data gathered during the experiments, about the ease of use of the game-like interfaces provided for the reenactment, the didactic value of the different stages, the interest of engaging in social discussions, etc. This valuable insight will serve to enhance our ongoing research activities in the area of information services, which deal with various flavours of technology-enhanced distance learning.

Commercial exploitation could happen through the selling of the technology, its implantation in the venues, training courses for professors, implementation of reenactment scripts and production of multimedia contents.

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REFERENCES

Akkerman, S., Admiraal, W., and Huizenga, J. (2009). Storification in History education: A mobile game in and about medieval Amsterdam. *Computers & Education*, 52(2):449–459.

Arends, M., Weingartner, M., Froschauer, J., Goldfarb, D., and Merkl, D. (2012). Learning about Art History by exploratory search, contextual view and social tags. In *Proceedings of the 12th IEEE International Conference on Advanced Learning Technologies (ICALT)*, Rome, Italy.

Charsky, D. and Ressler, W. (2011). "games are made for fun": Lessons on the effects of concept maps in the classroom use of computer games. *Computers & Education*, 56(3):604–615.

Fassbender, E., Richards, D., Bilgin, A., Thompson, W., and Heiden, W. (2012). VirSchool: The effect of background music and immersive display systems on memory for facts learned in an educational virtual environment. *Computers & Education*, 58(1):490–500.

Herodotus (author) and A. D. Godley (translator) (1922). *Herodotus, books V-VII: The Persian Wars*. Loeb Classical Library.

Jacobson, A., Militello, R., and Baveye, P. (2009). Development of computer-assisted virtual field trips to support multidisciplinary learning. *Computers & Education*, 52(3):571–580.

López-Nores, M., Blanco-Fernández, Y., Pazos-Arias, J., Gil-Solla, A., García-Duque, J., and Ramos-Cabrer, M. (2012). REENACT experiment - experiment problem statement, requirements and PIA review. EXPERIMEDIA project deliverable D4.9.1, http://www.experimedia.eu/publications.

Sala, L., Vannini, S., and Rubegni, E. (2011). Mobile learning in cultural institutions through the use of an Apple iPad application prototype. a case study at Monte Verità. In *Proceedings of Red-conference - Rethinking education in the knowledge society*, Ascona, Switzerland.

Salama, D., Garrido Ostermann, E., Ljungstrand, P., Softic, S., Prettenhofer, S., Boniface, M., Crowle, S., S.C.Phillips, Halb, W., and Konstanteli, K. (2012). First blueprint architecture. EXPERIMEDIA project deliverable D2.1.3, http://www.experimedia.eu/publications.

Watson, W., Mong, C., and Harris, C. (2011). A case study of the in-class use of a video game for teaching high school History. *Computers & Education*, 56(2):466–474.