# Proyecto Enreda Madrid

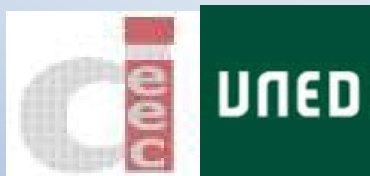## Autores:

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1. *INTRODUCTION*

Many scholars (Booth, 1994, Favero et al., 2007) confirm that history may be considered as one of the hardest subjects for students to fully understand due to the use of traditional teaching techniques. As a consequence, many history teachers and course developers have aimed at constructing different learning environments, in which interactivity techniques help effectively students to develop aptitudes to think historically (Anderson, 2004, Wiersma, 2008).

As soon as 1994, some authors (Spoehret al, 1994) already underlined the potential of information and communications technologies (ICT) to provide interactive learning for history. They used successfully computer-based hypermedia to teach historical thinking for US history and literature. Another approach based on web technologies (Appleford and Burton, 2007), which is Digital History was successful in engaging students in interactive history learning. Different authors (Vess, 2004, Toplak et al, 2007) have claimed that the role of computer technologies should be expanded for the benefit of history students.

More recently, Lo et al., (2009) developed a sophisticated web-based history educational system, HES-SPATO, to enhance the teaching of history that integrates very important elements of history events with a geographic information system for the student interface. Their results indicate that the use of these kind of systems is helpful for increasing students' history learning.

However, some authors claim that students do not benefit from the use of computers unless they are effective at self-regulating their learning (Azevedo, 2005). Following this concept, authors in (Greene et al, 2010) analyze how students use hypermedia learning environments to acquire knowledge of a historical topic and also historical thinking skills. They find that very often the students engaged in strategy use self regulated learning.

Also video games appear to be good tools to promote a learner-centered learning environment, as described, for example, in (Egenfeldt-Nielsen, 2005). They implemented the COTS game, Europa Universalis II,in a history course with Danish high school students, concluding that these games need to be carefully directed by specific educational goals to increase learning. Authors in (Watson et al, 2011) use also a video game, designed with educational purposes in mind, to teach World War II history. Their results clearly mean that the use of video games can promote students engagement.

Maybe the study most similar to our experience is the described in (Akkerman et al, 2009), that analyzes the use of a mobile and multimedia game, 'Frequentie 1550', designed for late medieval Amsterdam history education. In this one day game, secondary school students discover the history of medieval Amsterdam by using mobile phones, while they interact with different characters and explore buildings and events, that creates a rich narrative learning environment. Students use their mobile phones for communicating and exchanging information, for completing game assignments. The design of the game distributes three different roles for participants: actors, directors and spectators. The results of this study show how students that participate (actors) in the story and students that construct (directors) the story were more engaged and motivated during the game, than students that only receive (spectators) the story. Authors observe also that participants in the story were more active in the game but show less awareness of the whole story, while directors obtained a greater awareness of the whole story. They conclude that a careful combination on games of these two different storification

processes, enough involvement in the story as a whole and enough meaningful experience, help to obtain successful history education experiences.

This is only a short review of how computerand ICT technologies are being used successfully in different approaches for history teaching and learning processes. Recently other different computers and ICT tools have begun to be employed for other education domains. This is the case of Augmented Reality (AR), a technology that provides additional information on the real world through interactive features. It can be used onboth desktop-based computers and mobile devices and it is currently a fundamental piece in the emerg ing Internet of Things (García-Macias et al., 2011), that constitutes a mix of virtual and physical entities.

This technology can be applied to some of themany potential revolutionary applications in education, including the study of architecture, art, anatomy, languages (Yang et al.,2010), decoration, or any other subject in which a graphic, simulation or 3D model could improve comprehension (Zhou et al., 2008). Augmented reality could also be used together with QR codes in books to create augmented books in which imagesor simulations could complement the book content.(faltareferencia)

AR has been used recently (El Sayed et al., 2011) for building Augmented Reality Student Cards (ARSC), designed as a low cost solution for serving many different aspects related with the lack of education resources. In their successful application, authors claim that "ARSC can represent any lesson in a 3D format that helps students tovisualize different learning objects, interact with theories and deal with the information in a totallynew, effective, and interactive way. ARSC can be used in offline, online and game applications withseven markers, four of them are used as a joystick game controller". ARSC was used by 51 students from 10 to 17 of both genders and show that 89% of them were satisfied and think ARSC are specially valued for "science an biology" subjects. Students also affirmed it would be a good idea to use ARSC for other subjects as "Art & design", "chemistry" or "History".

AR provides huge opportunities for online teaching especially in science and engineering as these areas of knowledge need emphasis on practical training (Andujar, 2011, doctorando).

AR shows a great potential for education applications for which a learner must interact with realistic objects (Mantovani, 2003, doctorando) with less risk than the associated with the real objects. For example, a true AR environment (Blake et al, 2009) has been integrated in an agent-based infrastructure for supporting automotive manufacturing workers in the factory environment.AR has been also used for Automatics and Robotics subjects, as in (Jara et al, 2011), where real and virtual worlds are correlated by using automatic object recognition and AR techniques. Their RobUALab system allows students to simulate and control a robot in a real remote automated cell through Internet. Besides a prototype AR system has been used successfully (De Crescenzio et al, 2011) for improving the task's efficiency in aircraft maintenance training.

Authors in (Liarokapis et al, 2010, doctorando) show that for AR systems to be used successfully for learning processes, these systems must be robust, ease a clear and concise learning process and a simple interaction between student and teacher. The educator using the AR system must be able also to introduce new information in a effective and simple way. Finally the underlying technological processes must be transparent for the educator and the students.

As concluded in (Martin et al, 2011) the importance of mobile devices in education is fostering all the technologies related to them. As a consequence, AR uses in education is evolving also to mobile AR.

Authors have built an AR system that:
- it is integrated in a game that uses mobile devices, fostering interactivity and engagement of the students with the narrative story of the experience.

- it allows the easy introduction of multimedia information for documenting the game story.
- it allows to associate dynamically buildings, people and events in the Madrid of 1651, relating them with the current structure and urbanism of today Madrid.
- it obliges to students to mix different roles: they must be actors, by walking Madrid and resolving questions related with old Madrid, and directors, by building a complete picture of the proposed story.

The results of the experience may be useful for researchers interested on improving student engagement in subjects where the formative contents can be located around an area or a city.

The paper is structured in five main parts: an introduction; a methodology section, which describes the stages of the experience; a results section, which includes a compilation of the data obtained from the student satisfaction survey; a discussion section, which contains critical analysis of the results; and a conclusions section, which provides findings, highlights, constraints, benefits and direction for future research.

## 2. METHODOLOGY

The project involved a multi disciplinary team working together, including 8 History teachers, graphical designers, and mobile and e-learning researchers from other institutions.

The 5 main stages of the research were pedagogical methodology definition, content creation, e-learning development, mobile learning development, and evaluation. Each one of these stages is more deeply described below.

### 2.1. Pedagogical methodology definition

From a pedagogical perspective, the aims of the experience were:
- Student becomes proactive and looks for the contents instead of just receiving them. Thus, the student is receptive to receive information, which improves content assimilation and knowledge retention.
- The student must find the answer of a riddle to get information about how to continue in the gymkhana. Thus, the student feels curious about what is next in the game. Curiosity plays a fundamental role in concept assimilation.
- Students consider mobile devices as an entertainment tool. Thus, their use for mobile learning may increase students' engagement.
- The experience is designed as a role game. The contents are designed speaking in third person of the singular. Thus, they include the student in the History, e.g., "*You live in a 'corrala' in Lavapiés, which is the easiest and cheapest way to find a place to live in Madrid*", "*Remember the balcony where you used to be with the other members of the war council. You have belong to it for years, like your father*". This kind of language make students get more involved in the story of their character.

- Mobile augmented reality is visually very attractive, which mayiencrease student's attention.
- The student is learning concepts in the spots where the History took place, not in a classroom.This may also influence the student engagement and content assimilation improvement.

The first stage of the project was to design the pedagogical background of the experience. Authors chose a blended-learning model where both e-learning and m-learning were combined offering a wider set of educational tools to students.

The experience was divided in three main modules. The first one corresponded to the study of serveral technological and historical contents in an e-learning platform during the week before the gymkhana. The contents learned during this week helped students to understand how to use the technology during the gymkhana (i.e., augmented reality and social networks) and provided a basic historical framework to participate in the experience.

The second module corresponded to the mobile augmented reality gymkhana. In this stage, during only one day, students walked around Madrid discovering content in a role-based game. Each student had to chose a character in the history of Madrid in 1651. They could choose to become a noble, a ville chronicler or a commoner. Depending on the character that each student chose, they had to discover Madrid doing the same things that his character used to do. For example, a noble first in the morning take a walk in a carriage and then go to a palace, while the commoner goes to a fountain to take water and then look for job.

Students played this role game seeing the things that their characters saw and walking around the city as their characters did. This parallelism helps the students get more involved and engage in the experience, because they are feeling it in first person.

The organization provided the first clue of the gymkhana to the students in the starting point depending on their character. Using a map, they should go the first point of the gymkhana and look for some augmented reality content. Once they find the content in the augmented reality platform they could listen an audio explaining the things that their character did in that place. Then, they read some content and had to find the answer to a riddle. Once they find the answer the system tells them the next point of the gymkhana.

The experience was complemented with dressed up actors between the gymkhana points. Each one of these actors performed a small representation, depending on the character chosen by the students, explaining more details about each point and character . This representation helped the students to get even more involved in the role game and enjoy the experience.

Finally,  in the third module, students had to create a blog about their experiences in the gymkhana. This activity lasted one week after the gymkhana. In this activity students had to digest the knowledge acquired during the experience and show how they have assimilate what they have learnt.

## 2.3. Technology development

The third stage corresponded to the development of the technology that supported the experience, including the mobile augmented reality platform and the e-learning environment. Both environments are described below.

### 2.3.1. E-learning environment

The e-learning platform used to give support to the pre and post-gymkhana included the integration of the contents in a SCORM course, so that teachers could track students performance. Some of the contents were offered via interactive video-lectures to help students get an overview of what they must learn from History and ICT to participate in the gymkhana.

The environment also included communication tools, such as forums and chats, and a section to allow each student to publish their blog about the experience.

### 2.3.2. Mobile augmented reality platform

Regarding the mobile augmented reality platform, the first requirement of the project was that the content should be located around the city. Although currently there are many augmented reality frameworks and platforms, many of them are not location-based but code-based, e.g., ARMedia (http://www.inglobetechnologies.com/), LinceoVR (http://linceovr.seac02.it/), JSARToolkit (http://fhtr.org/JSARToolKit/).

The second requirement was to be available for as much users as possible. In this regard, many of the location-based frameworks are not designed for all operating systems, e.g., LibreGeoSocial (http://www.libregeosocial.org/) is only for Android, and JunaIO (http://www.junaio.com/) is for Android and iPhone. However, Layar (http://www.layar.com) and Wikitude (http://www.wikitude.com) are both available for Android, iPhone, and some Symbian and Blackberry devices. Finally, Layar was chosen as platform because many devices have Layar pre-installed and is more widely used in Spain than Wikitude.

Layar-based developments require the creation of a content-management system that serves the POI contents to the Layar client. Thus, authors have developed a context-aware server-side platform that serves contents depending on the student profile and location.

The functionalities provided by the augmented reality platform when a student find an augmented reality element are listed below:

- An image in augmented reality allusive to the place where the student is.
- A pop-up window at the bottom of the screen showing an image of the places and a short description of the feelings of the character in this place. This pop-up appears when the student touch the augmented reality image.
- An audio describing the actions of the character and the history of the place.
- A "more info" button that opens a window with extended information complemented with images about the place. Once the student has read and listen all the content, he/she must find the clue for a riddle given at the end of this window. It is mandatory to find the answer to the question to know the next point in the gymkhana.

The content prepared by the teachers was adapted to the mobile augmented reality platform as follows:

- Creation of a mobile-adapted Web page incorporating the text and images provided by the teachers for each point of the gymkhana.
- Location of the places, (i.e., latitude and longitude, where information will be provided in augmented reality.
- Creation of the augmented reality pop-up and their associated content.
- Link each location, pop-up and mobile-adapted Web pages.

### 2.3.3. QR Codes as Plan B

Additionally, QR codes were created for all the points with augmented reality elements just in case the server were down or the student's device did not support Layar. The requirements for using QR codes are less restrictive, basically a camera, than augmented reality, which requires GPS, gyroscope and accelerometer.

By reading these codes, students could access the same information obtained from augmented reality, except the information provided in the augmented reality pop-up.

## REFERENCES

AkkermanS., Admiraal W. and Huizenga J. Storification in History education:A mobile game in and about medieval Amsterdam. Computers&Education 52 (2009).

Anderson, T. (2004). Toward a theory of online learning. In Anderson, T., &Elloumi, F. (Eds.), Theory and practice of online learning. Canada: Athabasca University. Accessed December 2011 from: http://cde.athabascau.ca/online_book/ch2.html.

Andujar, 2011, paper de doctorando de Sergio

Appleford, S. and Burton, V. (2007). Digital history: Using new technologies to enhance teaching and research. [Web site reviews]. The Journal of American History.

Azevedo, R. (2005). Computer environments as metacognitive tools for enhancing learning. Educational Psychologist, 40.

Bates, A.M. (2005). T*echnology, e-Learning and Distance Education*, (2nd ed), Routledge.

Blake M. B. and Butcher-Green J. D. (2009). Agent-customized training for human learning performance enhancement. Computers & Education 53 (2009).

Booth, M. (1994). Cognition in history: A British perspective. Educational Psychologist, 29(2), 61–69.

De Crescenzio F., Fantini M., Persiani F., Di Stefano L.,Azzari P. and Salti S. (2011). Augmented Reality for Aircraft MaintenanceTraining and Operations Support. IEEE Computer Graphics and Applications, January/February 2011.

Dweck, C.S. and E.S. Elliott (1983): "Achievement motivation", in E.H. Hetherington (Ed): *Handbook of child psychology: Vol. 4. Socialization, personality and social development* (4th ed.). New York: Wiley

Eccles, J.S. and A. Wigfield (1985). "Teacher expectations and student motivation", in J.B. Dusek (Ed.) *Teacher Expentancies*. Hillsdale, NJ: Erlbaum.

Egenfeldt-Nielsen, S. (2005). Beyond edutainment: Exploring the educational potential of computer games. Unpublished dissertation. Copenhagen, Denmark: IT University of Copenhagen. Last accessed December, 2011, from: http://www.itu.dk/people/sen/egenfeldt.pdf.

El SayedN. A. M., Zayed H. H. and Sharawy M. I. (2011).ARSC: Augmented reality student card An augmented reality solution for the education field. Computers & Education 56 (2011).

Favero, L. D. et al. (2007). Classroom discussion and individual problem-solving in the teaching of history: Do different instructional approaches affect interest in differentways? Learning and Instruction, 17, 635–657.

Garcia-Macias J. A., Alvarez-Lozano J., Estrada-Martinez P. and Aviles-Lopez E. Browsing the Internet of Things with Sentient Visors. Computer, May 2011.

Greene J. A., Bolick C. M. and Robertson J. (2010). Fostering historical knowledge and thinking skills using hypermedia learningenvironments: The role of self-regulated learning. Computers & Education 54 (2010).

INE (2011): *Encuesta sobre Equipamiento y Uso de las Tecnologías de la Información y la Comunicación en los Hogares.*

Jara C. A., Candelas F. A., Puente S. T. and Torres F. (2011). Hands-on experiences of undergraduate students in Automatics and Roboticsusing a virtual and remote laboratory. Computers & Education 57 (2011).

Kaiser, U. and A. Spitz-Oener (2000). "Quantification of Qualitative Data Using Ordered Probit Models with an Application to a Business Survey in the German Service Sector", Discussion Paper 00-58, Centre for European Economic Research, Mannhein.

Liarokapis et al, 2010, doctorando de Sergio.

Lo J., Chang Ch., Tu H. andYeh S. (2009). Applying GIS to develop a web-based spatial-person-temporalhistory educational system. Computers & Education 53 (2009).

Maehr, M.L. and H.A. Meyer (1997): "Understanding motivation and schooling: where we´ve been, where we are and where we need to go". *Educational Psychology Review, 9, pp 371-409*

Mantovani, 2003, doctorando de Sergio

Martin S., Diaz G., Sancristobal E., Gil R., Castro M. and Peire J. (2011). New technology trends in education: Seven years of forecasts and convergence. Computers & Education 57 (2011).

McKelvey, R., and Zavoina, W. (1975): "A Statistical Model for the Analysis of Ordinal Level Dependent Variables", Journal of Mathematical Sociology 4, pp. 103-120

Ormrod, J.E (2011): *Aprendizaje Humano*, Pearson Prentice Hall, 4º edición.

Pintrich, P.R,; Marx, R.W. and R.A. Boyle (1993): Beyond cold conceptual change: The role of motivational beliefs and classroom contextual  factors in the process of conceptual change. *Review of Educational Research 63,* pp 167-199.

Spoehr, K. T. and Spoehr, L. W. (1994). Learning to think historically. Educational Psychologist, 29(2).

Stipek, D.J. (1993). *Motivation to learn: From theory to practice* (2nd ed.). Boston: Allyn & Bacon

Toplak, C., Pikalo, J. and Lukšicˇ, I. (2007). Teaching history to political science students: Historiography as part of political process. Innovations in Education and Teaching International, 44(4).

Veall, M.R and K.F. Zimmermann (1996). "Pseudo $R^2$ Measures for Some Common Limited Dependent Variable Models", Institut für Statistik Sonderforschungsbereich 386, LMU, paper 18.

Vernon, M.D. (1969). *Human Motivation*. Cambridge, England:Cambridge University Press

Vess, D. (2004). History in the digital age: A study of the impact of interactive resources on student learning. The History Teacher, 37(3).

Watson W. R.,Mong C. J. and Harris C. A. A case study of the in-class use of a video game for teaching high schoolhistory. Computers & Education 56 (2011).

Wiersma, A. (2008). A study of the teaching methods of high school history teachers. The Social Studies, 2008.

Yang, J. C., Chen, C. H. and Jeng, M. C. (2010). Integrating video-capture virtual reality technology into a physically interactive learning environment for Englishlearning. Computers & Education 55(3).

Zhou, F., Duh, H. B. L. and Billinghurst, M. (2008). Trends in Augmented Reality Tracking, Interaction and Display: A Review of Ten Years of ISMAR. InProceedings of ISMAR2008, Cambridge, UK.