Preparing Student Mobility Through a VR Application for Cultural Education

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Abstract. The potential of VR as a basis for developing dedicated applications for Cultural Education is explored through the design and development of a VR application called Celestial Breeze. Celestial Breeze is a dedicated application that aims to provide knowledge about the culture of different European countries. The design of the application is based on multimedia learning theories in an attempt to maximize the learning outcomes of the users. Emphasis is given in examining the effectiveness of Celestial Breeze as a tool of information dissemination in relation to the age and gender of the audience. We evaluated the application through a user study with 20 participants - half of whom were under aged- but all belong to Generation Y. The comparison of pre- and post- test results pinpoints the positive learning outcomes of Celestial Breeze on participants indicating in that way the potential of using immersive applications for cultural education.

Keywords: Virtual reality · Cultural heritage · Intangible heritage Tangible heritage · Virtual worlds · Culture · Social etiquette Multimedia design · Learning principles · Generation Y

1 Introduction

Recent advancements in the field of Virtual Reality (VR) provide numerous possibilities of using VR for Cultural Heritage (CH) related applications. This paper describes our ongoing work for foreign language students training in the cultural sector by exploiting an immersive Virtual Reality system especially designed to this end. Following a linear way of representation of information in line with Declarative knowledge strategy of learning [8], Celestial Breeze aims at raising students awareness regarding the cultural heritage of the European Union, prior

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to their mobility period. Users, immersed in the Celestial Breeze, took a virtual tour of selected European countries by popping up on a roller coaster.

In this paper, we first try to establish Celestial Breeze project within the current research and particularly in the field of virtual cultural learning for students mobility preparation. We will later present our adopted learning strategy as well as describe the system architecture. We shall further examine if such an application contributes to the knowledge and cultural awareness and on a second level if the gender and age of the learner play a role in this. Finally, conclusions and recommendations based on the findings of a pilot test aiming at a preliminary evaluation of the system will be drawn and the importance of cultural awareness in preparation for the period abroad will be discussed.

2 Literature Review

Literature analysis deploys several aspects that are significant to this research such as Virtual Reality and Cultural Heritage, Virtual Mobility and Learning Theories.

2.1 Virtual Reality and Cultural Heritage

Virtual heritage, namely the digitization and projection through virtual environments of the cultural treasures of the world, helps to preserve, research and the transmission of cultural heritage [7] but also to bring together people and different cultures without going there. The original purpose of virtual heritage is "the preservation and interpretation of our cultural and natural history" with "non-destructive public access" to heritage sites [7]. Celestial Breeze, could be seen as a vector of the virtual heritage, as it exhibits to the user authentic objects of different European cities which fall within the tangible and intangible heritage, facilitating the user to become familiar with the specific culture, before deciding to go there.

As the European Commission refers "Cultural heritage enrich individual citizens' lives, is the driving force for the cultural and creative sectors, and plays a role in creating and strengthening Europe's social capital. It is also an important resources for growth, jobs and social cohesion, providing the opportunity for the regeneration of urban and rural areas and promote sustainable tourism" [7].

The potential of combining education with entertainment [9] has been exploited through the development and evaluation of dedicated VR applications that aim to promote cultural heritage knowledge. In a comparative study of interactive systems in Leventis Municipal Museum in Nicosia, children between the ages 9 and 11 were asked to use and choose between six different types of museum exhibits, one traditional and five interactive ICT exhibits (VR tour, touch table, three augmented reality exhibits). The VR tour scored high on the question if they would like to do it again, which according to the researchers might be due to its enjoyable entertainment [15].

Another study compared the visit in two virtual museums (an engraving museum and a virtual Byzantine icons museum). In both cases users had the

opportunity to visit the museum using either a Head Mounted Display (HMD) or a stereoscopic Powerwall. Twelve participants were selected (7 female and 5 male) to take part in the study ranged in age between 20 and 40 years old and were from diverse vocational backgrounds and of different technological literacy levels. Overall, both technologies were considered a positive way to present cultural heritage to individuals and the virtual reality has easy portability for remote setups [13].

Virtual Reality applications have been touted as an effective source for teaching culture as the Y generation (persons born in 1980 and following that) [10] is more likely to engage in technologically advanced instruction than to merely interact with students or the instructor when in face-to face learning environments [5]. These assertions suggest that a virtual reality application could facilitate students learning of a foreign culture.

2.2 Erasmus Students and Virtual Mobility

Since 2014, around to 500,000 people participated in Erasmus+. Erasmus+, is a people exchange program, to which the key priority is the physical mobility activities, concerning education and training of the participants. The program enhances skills like language, occupation and inter cultural awareness and thereby the less privileged students are able to study abroad. While strengthening the participating organizations to increase their capacity for innovation, quality teaching and the ability to work with young people and modernizing curricula [2]. Virtual Mobility can be a supplement to physical mobility, but can also be an alternative to this. While physical mobility is increased to the Universities, the cost and the necessary facilities, difficult some students who wish to make the actual journey, so they can not have access, causing a kind of social exclusion can be avoided by means of virtual mobility (Kenyon, Lyon and Rafferty, 2002) [6].

According to the elearningeuropa.info, Virtual Mobility means: The use of information and communication technologies (ICT) to obtain the same benefits as you would have with physical mobility but without the need to travel [6]. Having that in mind, Celestial Breeze falls on the philosophy of virtual mobility, which offers the opportunity for students to take a course in another country through the use of ICT. In this way students acquire in addition to all the above positives offered by the Erasmus+ program and additional technical skills [6]. In this way Celestial Breeze could be used as part of Erasmus+ as a preparatory stage, since it can prepare virtual participants and thus facilitate the conduct of a smooth transition from one country to another [2].

There are four types of Virtual Mobility: (1) a seminar or virtual course as a supplement or section Higher education; (2) A virtual curriculum in higher education; (3) Virtual work placement; and (4) education and supplement the activities for an experience of physical mobility. The first three types of VM can be understood as a complement or substitute to physical mobility, while the latter could only work as an educational complement activity or to experience true mobility [6]. At present, Celestial Breeze falls in the first category, but the main goal in the future is to fulfill and the four types.

2.3 Mayer's Cognitive Theory of Multimedia Learning and Declarative Knowledge

The principle known as "Multimedia Principle" states that "people learn more deeply from words and pictures than from words alone" [8,14]. However, simply adding words to pictures is not an effective way to achieve multimedia learning. The goal is to instructional media in the light of how human mind works. This is the basis for Mayer's cognitive theory of multimedia learning.

Gagne and Briggs (1979) identified 3 subtypes of this major category of learning, each of which slightly involves different cognitive processes: labels and names, facts and lists, and organized discourse. Our main interest and instructional design of our Celestial Breeze is on labels and names. Actually, this type of learning involves pairing of information. Indeed, learners make a connecting link between two elements either propositional or image-based. Learning of labels becomes more difficult when the number of labels to be learned increases, or when connections between the idea pairs is less meaningful [8,11].

The learning of labels and names is often referred to as paired associate learning. Examples of learning labels and names are foreign language vocabulary learning, learning the names of the countries and their flags etc. In each case, a pair is linked together but its worth noting that linking labels does not necessarily require learning the meaning of the two linked ideas but rather learning that one thing links to another [8].

3 Design and Development

The methodology used for designing and developing this study was adapted from Alessis and Trollips theory based on multimedia learning [17]. Planning, designing and developing are the three main stages in this model. Based on the chosen model, the methodology proposes a set of standards that guides the design and development tasks. It also suggests other ways of being creative and brings onto the surface techniques that can be used for designing, developing and integrating numerous components of a multimedia application [17].

3.1 Analyzing the Learners

This project is addressed to intermediate level English learners who have basic computer knowledge. None of them had ever experienced VR instruction before. In general, members of this audience that reach this advanced level of education, have already developed their study skills yet with unfamiliar content, they tend to profit from concrete referents to ease their reasoning. The learners possess certain general world knowledge that will be helpful in learning through an immersive environment. The learners age generally ranges from 14 to 35. Half of them are children (i.e. ages up to 18 years) while the remaining are adults. Most of them are about equally divided between females and males. No color blindness or other severely limited visual problems were detected. None of them indicated that he/she had fear of heights.

3.2 Design Implications

To be easily learned, recalled, and used, new declarative knowledge must be tied to the Learners existing (i.e. prior) knowledge. As a matter of fact, in order to be stored in long-term memory, incoming information must be meaningful. Thus, it must be linked to some prior knowledge of it. In cases of little prior knowledge to form links with, learners have to employ artificial links that tend to focus on surface similarities. Similar sounds, shapes, sensory impressions, or motor procedures (as in our case) are such cases in point. When even these "tricks" cannot be made, one has to resort to sheer rote repetition to have the information be stored in long-term memory [16].

3.3 Celestial Breeze

In this study, we examined the cognitive consequences of learning in a Virtual Reality Environment designed to promote an understanding of cultural differences among selected European countries. Having that in mind, a Virtual Reality Learning Environment (VRLE) was designed and used: The Celestial Breeze[1] roller coaster in which the learner is called upon to discover different European cities while traveling on it.

The Celestial Breeze is based on experiential learning philosophy. Viljo Kohonen's "Learning is the process of creating new knowledge and understanding through the transformation of experience", to be more precise. In this case, experience is considered the use of a Virtual Reality Environment and the familiarity one has with European culture. Using something familiar, like European cities and their culture, helps the brain to fill in the gaps for the unfamiliar which is the new knowledge provided by the roller coaster experience [17].

3.4 Developing

Devices and Equipment. The application was developed using the game engine Unity 4.6.1 in which the programming, level design and implementation of animations and text was done. The VR setup included the Oculus Rift DK2 and a desktop computer which was equipped with an NVidia GeForce GTX 770 graphics card. The modeling of the featured items was made using Autodesk Maya 2014 and for their texturing Adobe Photoshop CS6 was used. For the editing of the music, Audacity 2.0.6 was used. To achieve easy interaction, conventional input devices such as keyboard and mouse were used. The optical output from Oculus Rift DK2 was combined with audio using headphones in order to enhance the immersion experience.

[1] A video showing the VR application Celestial Breeze is available at https://www.youtube.com/watch?v=y2SzIMX6xfw.

The Virtual Ride and the Featured Objects. The roller coaster is a simple ride with the same beginning and end. The learner is placed in a round cart which then transports them slowly along the ride. While the user moves along, he will be able to see on the left and right hand side, various 3D objects which belong to a specific country, along with a description of that object (Fig. 1). Additionally, the flag of each country also appears on the side of the railway track in the beginning of each country, indicating to the learner the country he is passing by. These signs contain information for each object and pop up whenever the learner is in a close distance. The countries are presented sequentially, accompanied by four or five representative objects and their relevant information in close distance following Mayers Multimedia principle. Although it is a roller coaster, the learner has the ability to adjust the speed, allowing him to stop whenever he wants to and thus observe the object and read the information provided. The information for each country is be a variety of interesting facts that relate to culture, pop culture, history, geography, cuisine, traditions, social etiquette, phrases and transportation to name but a few. The information shown for each image does not exceed the size of a post-it note as having too much text on screen would bore the learner and discourage them from continuing the ride. Our sources of information were primarily received by Wikipedia [4] and the justlanded.com site [3]. The information is related to tangible and intangible CH of the aforementioned countries. These countries were chosen as they are the most popular receiving countries throughout Europe for Erasmus+ students [1]. The majority of the relevant studies were primarily focused on museums and their exhibits or tourism of a particular country as those represent a knowledge that is mostly common to people (related to Viljo Kohonen's experiential learning philosophy [12]).

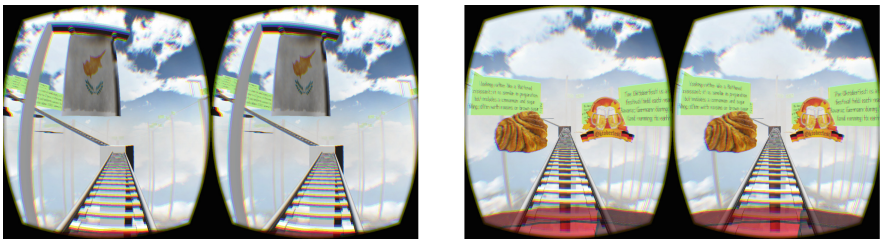

Fig. 1. Two screenshots from "Celestial Breeze". On the left the Cypriot flag indicates the country the learner is passing by. On the right two 3D objects from Germany along with their description.

A formative and a summative evaluation report for Celestial Breeze was conducted. The formative evaluation included design reviews confirmed with a survey given to tutors of English in FL classrooms with years of experience. The survey included questions about the following: existing curricula, instructional facilities as well as community organization and mores. The task analysis and test

specifications were reviewed by instructional designers and revised upon their input. These data lead to a further revision of the task analysis. Once Celestial Breeze was produced and questionnaires were printed, they were reviewed by two experts in multimedia design and their suggestions were incorporated in further revisions of the virtual reality application.

4 Experimental Evaluation

4.1 Methodology

Participants. The experiment involved 20 individuals (9 men and 11 women). People were divided into 2 focus groups based on their age. In group A, there were 10 adults aged between 19 and 35, while in Group B, there were 10 children aged 14–18. The majority of the participants did not have a previous experience with VR. Note that for children, parental consent form was primarily requested.

Fig. 2. A participant immersed in "Celestial Breeze", reading an information sign.

Evaluation. The overall goals of the evaluation include the following questions: I. How much information does the Celestial Breeze communicate? II. Is it fun to join in? III. Is the design of the 3D environment considered a convincing one? A common approach to analyze the effectiveness of immersive education applications is the comparison of pre and post-test results to highlight the learning effect. These were embedded in questionnaires that were used to detect strengths and weaknesses in the design and the usability.

A within group experiment was conducted in which quantitative data were collected using pre- post- questionnaire. For Group A that consisted of adults, there was no previous reference to the topic, while they were granted by a pre-test questionnaire. The pre-test consisted of factual questions about participants including age, sex and job title as well as value questions including attitudes, opinions and expectations, closed-ended questions with Yes or No answers, Like or Dislike and rank ordering responses. To check any prior knowledge, the third Section of the pre-test involved 9 multiple choice questions evaluating information about the European countries mentioned in the VR application. The post-questionnaire test, which included the same 9 questions, examined the retention

of knowledge (if any) gained from the virtual experience and was used to determine the overall satisfaction. The main difference was that the questions of the pre- test did not follow the same order and 8 more multiple choice questions were added to the post- test. These latter questions examined if any further knowledge was gained and thus if Celestial Breeze can be considered as a convincing way to learn. All these multiple choice questions in Section B of the second questionnaire evaluated the load of information the Celestial Breeze can communicate. This methodology was followed for both groups. On average, the whole procedure lasted 25 min.

Experiment. The participants (Fig. 2) were firstly given the pre-questionnaire to fill. Then they were fitted with the Oculus Rift and the headphones and the next stage was the virtual experience through Celestial Breeze (Fig. 2). The learners spent around 15–20 min tuned in. After the virtual experience, the Oculus and the headphones were removed from the participants and they were asked to fill in the post-questionnaire.

Results. Following the procedure mentioned above, the preliminary usability results prove that the Celestial Breeze virtual reality application has the potential to be used as a succor of learning the differences in European cultures and etiquettes and to further serve as a valuable educational tool. Specifically, from the user interface part, experts agree that the application is clearly designed and system information provided is consistent and related to the task; hence intuitive interaction is offered. The fact that the participants are free to move into their ride at their own pace. In terms of learning, there was a comparison of the knowledge questions in pre- and post- questionnaire. The overall percentage of correct answers at pre-test questionnaire for children of both genders, was 48.8%, while after the VR experience the answers increased to an overall of 63%. In particular, the boys mentioned an enormous increase to the proportion of their correct answers, from 44.4% to 70%; while girls showed a relatively lower increase: from 50.7% to 58.8% of correct answers was observed. Yet, adults who in the pre-test questionnaire had scored an overall of 61.4%, in the post-questionnaire test the percentage decreased to 60% (Fig. 3). The decrease in the performance for adults was mainly attributed to male adults whose negative performance was linked to the 'lack of fun element', indicating the importance of user satisfaction in the learning process.

Regarding the element of visual ride fun, in the pre-test questionnaire 8 out of the 20 participants answered that they liked it, while the 80% mentioned that the former reason to join in such an experience would be out of entertainment and curiosity while infotainment (a combination of information and entertainment) comes after. It should be also noted that none of the participants had previously a virtual reality experience. The importance of fun was also confirmed in the evaluation of Celestial Breeze post-questionnaire. Indeed, in the Yes/No question, 17 out of 20 people answered that they did enjoy their ride

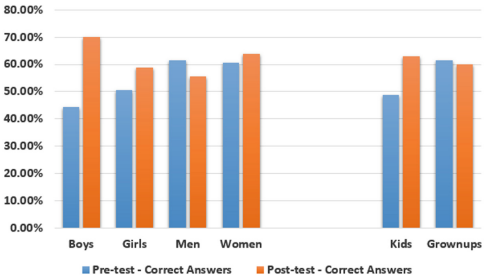

Fig. 3. The percent of correct answers in the pre- and post- questionnaires based on the gender and age of the participants

but in the following open-ended suggestion box, most of them stated that they missed the fun element related to a real world roller coaster.

5 Conclusion - Future Work

Virtual reality, multimedia design principles and learning strategy are of great significance for learners' acquisition of knowledge. The study examined the effect of a virtual reality environment combined with the aspects of learning and fun within two different age groups; children and adults. The preliminary results of the study show that the Celestial Breeze application can have an important impact on knowledge acquisition by younger people and women.

Since the results showcased that the ride could have been more entertaining a game-style motivational element shall be applied in the future to keep the learners focused. Instead of being just viewers in the roller coaster, the learners could become directly involved with the process by allowing more freedom and interactivity within the application. For instance, when arriving at the point where Napolon Bonaparte is located, the mood could suddenly change and the 3D model could come to life. The user could then enter a QTE (Quick Time Event) by pressing various prompts appearing on screen, to interact with the 3D model so that the user is directly implicated in the actions.

As far as the style of the information provided, the captions would be probably a better choice for a participant wishing to learn rather than sentences and iconography would be better fitting for something as interactive and virtual as this experience. Iconography, if done well, can offer more information that text. Smaller details such as different weather conditions, traditional music from each country and a lessening of the experience time length (approximately 10 min) would facilitate both the learning experience and its outcomes. Additionally, the countries could be reduced and instead of having a quiz after visiting all of them, we could create a smaller interactive application of a quiz with leader-boards, which would make it more entertaining to interact with as it will be less passive and more competitive.

Concluding, Celestial Breeze can be used as an educational tool of cultural awareness for English intermediate level learners as proved by the results. The Y generation learners can effectively and actively engage in such a learning method developing cultural awareness. Of course, the primary goals were achieved successfully by a small sample of participants. To pertain concrete results, further tests applied to a larger sample need to be staged.

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