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Designing Serious Games for ICH Education

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***Abstract* — The paper presents the experience matured in the i-Treasures project, in which 3D game-like applications were designed and developed with the aim of providing innovative tools for Intangible Cultural Heritage (ICH) education. The decision to develop Serious Games grounded on the specific learning needs linked to the nature of the ICH considered (dances, craftsmanship, singing expressions, etc.) and to the benefits that the research in Games Based Learning has pointed out regarding the use of games with educational purposes. In the paper, the i-Treasures game-like applications are described, with particular attention to the design and developmental process that was carried out with the involvement of a multidisciplinary team. In the game development, a huge effort was put into making the most of the benefits of games; these aspects will be discussed and highlighted. The difficulties met will be discussed as well, so as to provide a clear idea about the process and the issues encountered.**

***Index Terms* — Intangible Cultural Heritage (ICH), Serious Games, Innovation, Collaborative research projects.**

I. INTRODUCTION

In the last decade, the safeguarding of Intangible Cultural Heritage (ICH) became central in the UNESCO policy [1]. Countless programmes and projects have been developed in the field but taking a close look at the concrete experiences, it is evident that most of them took an archival approach, meaning that their outcomes often take the form of digital archives or inventories of materials, aimed to at documenting the cultural expression at hand [2].

This kind of resources can have an important role in ICH transmissions, since so far it has been carried out mainly in informal contexts by means of personal exchanges and oral tradition, but their impact could be limited if we think of the passing down of cultural expressions in terms of performance.

The advent of innovative technologies can help to go beyond the encyclopedic approach and provide useful resources for ICH education, aimed not just at showing and transmitting information but also at supporting the teaching and learning process in an active way.

The i-Treasures project [3], by assuming this latter perspective, aims to go beyond the mere digitalization of contents for preservation purposes; it aims to develop an advanced platform both for ICH preservation and education. The project tackles several cultural expressions belonging to four different areas (singing, dancing, music and craftsmanship). In these areas, besides learning theoretical information, learners need to acquire practical skills, by acquiring procedural knowledge (i.e. *how to perform* some tasks). This is the reason why, so far, in most cases, knowledge has been transmitted mainly through apprenticeship, where apprentices acquire procedural knowledge by observation or imitation.

The i-Treasures project proposes to use innovative sensors and ICT technologies (optical, depth or inertial sensors, EGG and EEG sensors, etc.) to "capture" the experts' procedural knowledge and uses these data with educational purposes.

This is done thorough 3D game-like applications which allow not only to watch and reproduce the experts' performance, but – even more importantly – to capture the learner's performance and then compare it with that of the expert. This gives the learner the opportunity to get personalized feedback and increase her level of competence.

In the following, we explore the rationale behind the adoption of Serious Games in the specific field of ICH education. Afterwards, we introduce the already developed 3D applications, so as to provide an idea about how the game assets were exploited. Lastly, we discuss the main challenges faced during the design and developmental process.

II. USING GAMES IN ICH EDUCATION: RATIONALE

The use of digital games is not new in the field of Cultural Heritage [4] especially in the Tangible Cultural Heritage (TCH) area. A small number of games have also been developed in the field of Intangible Cultural Heritage (ICH), where they are also considered very promising; nevertheless, the existing ones are mostly oriented to increase cultural awareness about customs, traditions, spiritual beliefs, folklore

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and social rules, as well as the influence of past events on a society [5].

Therefore, the i-Treasures experience represents an important innovation in the field, since the games developed by the project have completely different objectives and tackle different aspects of ICH compared with the existing ones.

The decision to develop this kind of learning environment, namely games, was grounded on the benefits highlighted by several studies in the research area of Game Based Learning.

It is widely recognized that games offer an appropriate environment for situated learning since they may happen in virtual environments resembling or representing the real context in which they occur [6]. This aspect is key in ICH education, where the teaching and learning process needs to be rooted to the context where the ICH is traditionally performed and the context itself plays an important role and has got a value.

Games promote extrinsic and intrinsic motivation [7] through the setting up of goals and rewards [8]. Games are also engaging, namely they make learners invest effort and commitment in learning tasks [9]. Both these aspects are really important in the light of building stimulating learning environments, to be used even without the help of a real teacher or expert in the field.

Another asset of games is their ability to support self-regulated learning [10]. The possibility of taking control of one's own learning process and behavior turns out to be very important in ICH education, where learning is generally linked to a personal choice and is usually performed in non-formal/ informal learning contexts.

Another essential aspect is that games are recognized as effective in supporting the learning of procedures and gestures (and also of sequences of gestures and physical actions); in this flow, they are widely adopted in professional training [11]. As is evident, this is an essential asset in the case of ICH, where, besides the uptake of the history of the cultural expression, the learning process needs to be grounded on the observation and imitation of the experts' performance. The i-Treasures project exploits this potential and uses SGs to train motor skills and to support sensorimotor learning.

SGs' educational potential and actual effectiveness, though, may vary appreciably as a consequence of the design choices. This is the reason why the project devoted a lot of time and effort in the design process.

In the following we explore the already developed 3D applications, paying a particular attention to the design and developmental process. Lastly, we discuss the main challenges faced during the process, since this represents quite an innovative field.

III. THE 3D GAME-LIKE APPLICATIONS DEVELOPED

During the first phase of the project, four novel game-like educational applications were developed, one for each of the four ICH use cases considered in the i-Treasures project: i) Human Beat Box (HBB) for rare traditional singing; ii) the popular Greek Tsamiko dance for rare dances iii) the art of pottery making and iv) the contemporary music composition. All the games combine data from multiple sensors, such as Microsoft Kinect v1 and v2[1], Leap Motion[2], Animazoo[3], Emotiv[4], and sensors for tracking the vocal tract.

The design and development of each game required input from different professionals: the experts of the cultural expression at hand, the technical people who are experts of the sensors to be used, the technical people who developed the game itself, the educational technologists and methodologists who provided guidance about the educational and pedagogical aspects of the game, etc.

The game design started from a phase of requirements elicitation which covered not just the aspects strictly linked to the game itself, but also what features needed to be captured (and used for the comparison of the learner's performance with the expert's one) [12]; therefore, the main features of each ICH were identified with the help of the experts. This process led to the selection of the most suitable sensors to be used for capturing the identified features of each ICH. For example, in the pottery case both the hands (in detail) and the upper part of the body (arms, trunk, etc.) turned out to be important for pottery creation. Therefore, Kinect was identified as suitable for tracking the upper part of the body, while hands were tracked by the leap motion technology. In the HBB case, experts and professionals agreed to track the vocal tract with a system developed for speech production and recognition, consisting of a lightweight "hyper-helmet" containing an ultrasonic (US) transducer to capture tongue movement, a video camera for the lips, and a microphone [13].

As for the learning process, a sound pedagogical background was ensured through a set of guidelines, which led to the definition of a common structure of the games and, at the same time, guided the actors involved in identifying specific aspects of each game. Each game was, then, implemented according to the specific ICH domain handled and, therefore, sensors and technology adopted [14] [15].

As a result of this approach, the four games share a common structure [16]. The main page leads to an introductory activity ("Getting started") followed by a sequence of training activities with increasing difficulty levels. The last one is a final challenge to be faced at the end of the training activities (see Fig. 1).

Each training activity is structured in two phases: "Observe" and "Practice" in order to guide the learner to observe the target move (or listen to the target sound) before trying to reproduce it. In the practicing phase the learner is requested to put on the sensors and to reproduce what she has seen in the "Observe" phase. Her performance is compared, thanks to an algorithm developed on purpose [16], with the expert's performance (who was previously tracked with the same sensors). This structure recreates a realistic learning situation where the expert/teacher firstly displays some moves (steps, sounds, etc.) and then asks the learner to try to reproduce it.

[1] http://www.microsoft.com/en-us/kinectforwindows/
[2] https://www.leapmotion.com/
[3] http://www.animazoo.com/products
[4] http://emotiv.com/epoc/

Fig.1. Pottery game menu

Given the complexity of the ICHs considered, experts have identified some basic stages that could be taught using the game. Each game encompasses multiple scenes and multiple levels. Different scenes of the same difficulty form a specific difficulty level. The learner needs to overcome a pre-defined threshold (fixed by the experts) in order to move on to the following activity (see Fig. 1). For example, the Pottery game includes a sequence of tasks aimed at making the learner acquainted with the very first phases of pottery creation (e.g. throwing and centering the clay on the wheel, pricking the clay in the middle and forming the bottom of the object, etc.). This structure, based on a traditional game mechanic which is the progression in difficulty levels, mimics a possible learning situation and at the same time increases the motivation and engagement of the learner.

Games scenes reproduce a realistic learning situation (a dance, pottery or recording studio), so as to enhance a situated learning experience. For example, in the Tsamiko dance game, the 3D environment represents a modern dance studio with parquet floor and a big mirror on the back wall (as shown in Fig. 2 and 3). This mirror has the same function as in real dance studios by providing a reflected image of the dancer. For the final challenge activity, a 3D model of the famous "Odeon of Herodes Atticus" in Athens is designed so as to provide an environment more appealing for a final performance.

Games also allow one to have an enhanced visualization of the performance. In the Observe screen, the learner can see the expert's avatar (in the main window) and video, as well as some parts of the body of the avatar mainly involved in the performance (Fig. 2).

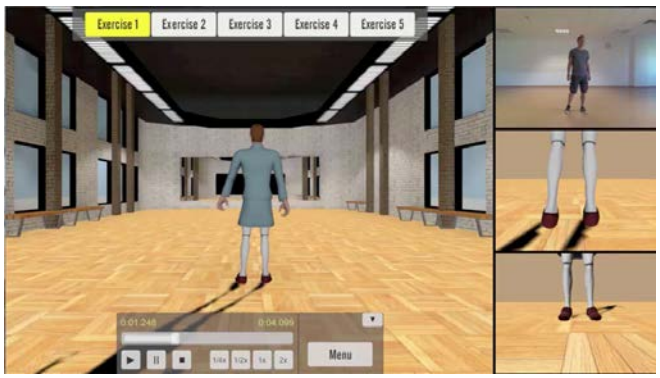

Fig 2. Tsamiko game observe screen

In the practicing screen, the learner can visualize her avatar and the expert avatar alternatively in the main window or in the small one, together with the expert video and parts of the body (Fig. 3).

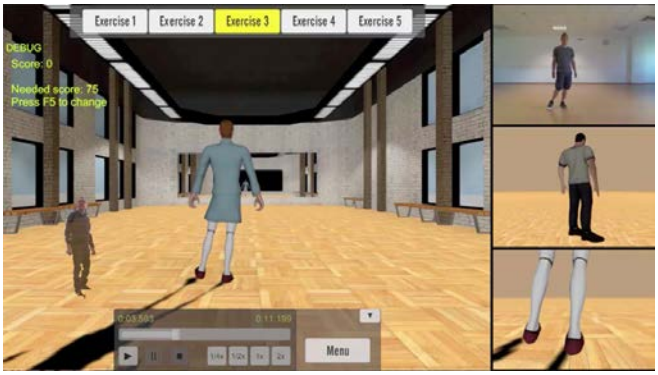

Fig. 3. Tsamiko game practice screen

IV. DISCUSSION

This first round of design and development of the 3D game- like applications turned out to be more challenging than expected. Several factors can be identified behind the challenges faced.

The strong interdisciplinary nature of the project represents the background challenge the consortium had been facing since the project started. This had, of course, an impact also in the first round of game development, since the group working on the game design and development was varied in competences. This aspect represents a benefit, since the game design was accurately considered from all sides, including the educational soundness and effectiveness that could run the risk to be overwhelmed by technical issues. The collaborative effort, nevertheless, was demanding and required continuous and recursive interactions among all the people involved.

As said above, the educational soundness of the games represented a significant issue: a great effort was required from educational technologists to stress the importance of the pedagogical aspects. This was done trying to guide the design process towards the necessary definition of the learning objectives and the learning strategies to be adopted in the games. Therefore, to ensure the pedagogical effectiveness of the games, general guidelines were used. In these guidelines, some aspects were defined a priori (e.g. the articulation of the games in two phases: observe and practice) according to learning principles, while others were tackled through discussion and negotiation [14].

The necessary segmentation of knowledge in stages could shadow the playful "side" of the 3D environments and the motivational and engagement dimensions of the game-based activities. To avoid this, the game mechanics were accurately designed for each game, e.g. a score system was set up according to well defined thresholds and scores are displayed in an appealing color bar; a final challenge is also proposed, where the learner performs in competition with him/herself.

Other aspects requiring the educational technologists' support were more linked with the delivery of information and their visualization. In an educational game, some aspects like what info needs to be visualized and how to organize it on the screen, are central in order to have an effective tool. Even though Human Computer Interaction (HCI) research gives valuable directions, again the needs and constraints brought by each cultural expression posed several problems. These problems were faced, game by game, finding different solutions agreed from time to time with the experts and the teachers, so as to provide learners with all the necessary information without overwhelming them.

The developmental process also posed several technical challenges; a detailed description of them is beyond of the scope of this paper, since they are extensively discussed in Yilmaz et al. [17], but it is worth briefly introducing the main issue encountered. The integration of different types of sensors and software modules and their communication with the 3D visualization module, turned out to be the most difficult technical issue. Solutions have been implemented from time to time, but for sure further work needs to be done, especially to reach precision and accuracy of feedback.

V. CONCLUSIONS

The i-Treasures project, aims at making the most of innovative tools and methodologies to support ICH education.

One of the most ambitious outputs expected by the project, is the development of 3D game-like applications aimed at supporting teaching and learning of procedural skills and knowledge that are needed to perform a certain ICH.

Games are expected to be effective tools for ICH education and have characteristics which can be seen as assets in the ICH field. For this reason, the i-Treasures project is trying to exploit their potential. A first round of development of these applications was carried out, giving birth to four games, one for each of the ICH category considered.

The process turned out to be more challenging than expected, due to several factors, like the different professionals involved, and due to some educational and technical issues.

Overall, the experience has proved the feasibility of the i-Treasures approach, even if several issues still remain open and will deserve further attention in the future.

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