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# SERIOUS GAMES TO SUPPORT LEARNING OF RARE 'INTANGIBLE' CULTURAL EXPRESSIONS

**Francesca Maria Dagnino[1], Michela Ott[1], Francesca Pozzi[1], Erdal Yilmaz[2], Filareti Tsalakanidou[3], Kosmas Dimitropoulos[3], Nikos Grammalidis[3]**

[1] *National Research Council (CNR) –Institute for Educational Technology (ITD) Genoa, (ITALY)*

[2] *Argedor Information Technologies, Ankara (TURKEY)*

[3]*Information Technologies Institute, Centre for Research and Technology Hellas, Thessaloniki, (GREECE)*



## Abstract

The paper deals with the adoption of Serious Games (SGs) in the specific area of Intangible Cultural Heritage Education (ICH). The transmission of some cultural expressions, like rare traditional singing or dancing, is more related to the acquisition of procedural knowledge (i.e. how to perform some tasks, like a dance step) rather than to declarative knowledge (i.e. knowledge that can be declared or stated through words or symbol systems, e.g. music notation). Coherently, so far knowledge in these areas has been transmitted mainly by observation or imitation of experts/performers in real contexts. Grounded on the research results in Game Based Learning and on the opportunity offered by cutting-edge sensor technologies, the i-Treasures project exploits the interesting potential of Serious Games in the ICH field. As a matter of fact, the capacity of games to train motor skills and to support sensorimotor learning, together with their ability to enhance engagement and motivation, are the main elements at the heart of our choice. In the paper, we discuss in depth the theoretical rationale behind the adoption of Serious Games i-Treasures, also in the light of their current use in Cultural Heritage Education. Furthermore, the paper describes the main game design principles adopted by the i-Treasures project to address the specificities of various artistic expressions and to make the games sound and effective tools to support practice and learning.

Keywords: Innovation, Research projects, Game Based Learning (GBL), Intangible Cultural Heritage.

## 1 INTRODUCTION

In recent decades, particular attention has been devoted to the safeguarding of Intangible Cultural Heritage (ICH), namely to: "the practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artefacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their cultural heritage" [1]. These cultural expressions have survived up to the present but are now being threatened by globalization, which is causing a loss of interest in local cultural traditions.

For this reason, UNESCO undertook several actions, such as the promulgation of the Convention for the Safeguarding of Intangible Heritage (in 2003) or the yearly publication of a "List of Intangible Cultural Heritage in Need of Urgent Safeguarding" and a "Representative List of the Intangible Cultural Heritage of Humanity". The main aim of these initiatives is to ensure the survival of ICH expressions, by means of the identification, preservation, protection, promotion and transmission (particularly through formal and non-formal education) as well as their revitalization.

Education could certainly have a role to guarantee a future to these endangered cultural expressions, that so far have been passed down mainly in informal contexts, by means of personal exchanges and oral tradition. In this perspective, the i-Treasures project [2] is trying to boost chances at educational level, by developing novel methodologies for the analysis and modelling of a selected group of intangible cultural expressions, with the final aim of offering innovative and effective "technology-enhanced" teaching and learning solutions. In particular, the project aims to exploit the potential of digital games at educational level both for their capability of motivating learners and of supporting gestures and procedural learning, as will be discussed below in section 3.1. As a matter of fact, when dealing with ICH, learning is more related to procedural knowledge (you should learn how to perform some tasks, like a dance step), rather than to declarative knowledge (i.e. knowledge that can be declared or stated through words or symbol systems, e.g. dance or music notation).

So far, four novel 3D game-like educational applications have been developed, one for each of the four categories of ICH studied within the i-Treasures project [3], and others will be developed soon.

As will be discussed later, the adoption of game-like applications in i-Treasures follows a quite well consolidated trend in the Technology Enhanced Learning field [4]. Their use has been planned in the context of educational paths conceived to integrate these resources with other meaningful traditional or innovative activities and tools [5].

In the following, we outline the mission and some key aspects of the i-Treasures project; we, then, explore the current use of digital games in Cultural Heritage Education and present the rationale that led us to adopt games in this specific field. Lastly, we describe the design principles that guided the game-like application design, according to the specificities of each cultural expression considered.

## 2 THE I-TREASURES PROJECT

i-Treasures ("Capturing the Intangible Cultural Heritage and Learning the Rare Know-How of Living Human Treasures") is an Integrated Project (IP) co-funded within the European Union 7th Framework Programme. Its final aim is to "*develop an open and extendable platform to provide access to ICH resources, enabling knowledge exchange between researchers and contributing to the transmission of rare know-how from Living Human Treasures to apprentices*" (Project Description of Work - DoW )

i-Treasures considers a number of different ICHs, belonging to four different areas (singing, dancing, music and craftsmanship). Each use case has been further instantiated in different "sub-use cases", namely:

- singing: Canto a Tenore, Canto in Paghjella, Byzantine music and Human BeatBox;
- dancing: Tsamiko, Căluş, Walloon and contemporary dances;
- craftsmanship: the art of pottery in Greece and France;

- music: contemporary music composition.

The i-Treasures core mission is thus to sustain and foster the transmission of these ICHs, by making use of cutting-edge technologies.

In particular, i-Treasures adopts new methods and technologies (optical, depth or inertial sensors, electroglottograph and electroencephalogram sensors, etc.) in order to capture specific features of each cultural expression considered, then a process of data modelling is carried out by relying on advanced Semantic Multimedia Analysis techniques, so as to identify specific media patterns (e.g. postures, gestures, audio patterns, actions etc.). These data are then stored and made available on the platform for preservation, dissemination, research and teaching purposes.

These data are also used as a reference in the game-like applications conceived to support the training and evaluation of the learners' performance. Using these applications the learner has the opportunity to practice dancing, or singing and receives immediate and personalized feedback about the quality of her performance, so to improve her level of competence and practical skills. The learner's performance is assessed by the system and the evaluation is based on the degree of similarity between his/her gestures and the gestures performed by experts through algorithms developed purposefully.

# 3 GAME ADOPTION IN CULTURAL HERITAGE EDUCATION

Information and Communication Technologies (ICTs) are increasingly becoming one of the pillars of Cultural Heritage Education [6],[7]. Virtual worlds are often used in the field of Cultural Heritage education in order to broaden the opportunity to appreciate cultural contents that are remote in space and/or time. Even though they should be considered very helpful for widening access to cultural contents, these applications, for example Virtual Museums, are often not intrinsically engaging and sometimes fail to support active learning, merely giving the opportunity to access information [8].

As extensively explained hereunder, digital games support learning in a more active and engaging way and, from the pedagogical viewpoint, they offer advanced interaction such as the possibility of customizing the learning paths and of keeping track of the learners' behaviour and successes/failures and are more adaptive to meet the specific users' learning needs. For these reasons, in i-Treasures it was decided to support sensorimotor learning with game-like applications aimed at supporting the learning and transmission of the considered ICHs.

Here we offer a quick look to the present panorama of game use in Cultural Heritage education and, afterwards, we summarize the rationale behind our choice of adopting games in our project.

## 3.1 Current use of Serious Games in Cultural Heritage Education

As to the digital games available in the Cultural Heritage (CH) area, Anderson and colleagues [9] and later Mortara and colleagues [8] carried out interesting State of the Art reviews. The first review is more focused on technical aspects while the second sketches a panorama of the actual use of Serious Games in Cultural Heritage education.

According to Mortara et al. [8] in the field of CH, SGs of different kinds are adopted: from trivia, puzzle and mini-games to mobile applications for museums or touristic visits, (e.g. 'Muse-US'[1], 'Tidy City'[2] ) to simulations (e.g. the 'Battle of Waterloo'[3]) to adventures and role playing games (e.g. 'the Priory Undercroft'[4]).

As might be expected, games are more widespread in the Tangible Cultural Heritage (TCH) area, where several different examples can be found [10].

Among these, we can mention 'Thiatro'[5], a 3D virtual environment where the player acts as a museum curator, or other digital artefacts such as the 'History of a Place'[6], which is an integral part of a museum experience at the Archaeological Museum of Messenia in Greece. Many games have also been developed in the area of historical reconstruction, for instance the 'Battle of Thermopylae'[7] or the 'Playing History'[8]. These games are mainly based on 3D technology in order to closely recreate the environment in which each single event happened. A number of games for smartphones also exist like 'Tate Trumps'[9] or 'G. Averof'[10] which, for instance, have the scope to allow museums visitors to create and share their own media and stories through smartphones.

Although to a lesser extent, a number of games have also been developed in the field of Intangible Cultural Heritage transmission, where they are also considered very promising. Some existing examples are [8]:

- 'Discover Babylon'[11] that is aimed at raising awareness about ancient Mesopotamia's contribution to modern culture or 'Remembering 7th Street'[12] aimed at showing West Oakland in the time period post-World-War-II.
- 'Real Lives 2010'[13], that simulates a different life in any country of the world (e.g. a peasant farmer in Bangladesh, or a computer operator in Poland).
- 'Papakwaqa'[14], a serious game about the Atayal minority in Taiwan, particularly focused on intangible cultural assets like tribal beliefs, customs, and ceremonies.
- 'Icura'[15], a 3D realistic environment in which the player can learn about Japanese culture and etiquette. This can be useful to raise cultural interest and support a real pre-trip planning.



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## 3.2 Rationale behind the adoption of games in the i-Treasures project

At present digital games are being increasingly adopted to sustain learning and training in a variety of educational fields (school education as well as military, medical training etc.); this is done for a wide range of target populations, ranging from children to adults [11]. The educational potential of games has been widely explored and highlighted by researchers within the wider research area of Game Based Learning [12],[13],[14],[15].

Digital games employed in education can be broadly subdivided in two categories [16]: 1) mainstream games, i.e. games that are created solely for fun and 2) learning games, i.e. games that are expressly designed with explicit educational purposes. Games in this last category are also referred to as Serious Games (SGs) [17],[18],[19]. The i-Treasures game-like applications can be reasonably considered Serious Games since they have been built having in mind a "serious" educational purpose.

In the following, we summarize the reasons why in i-Treasures we chose to design, create and adopt Serious Games as training/educational aids to support ICH learning and transmission.

### *3.2.1 Games support constructive, experiential and situated learning*

Hainey and colleagues [20] suggest that games support constructive, experiential and situated learning; these are all aspects that modern theories of learning suggest as central for effective learning. Boyle, Connolly & Hainey [21] stated that learning with computer games can be (and often is) consistent with constructivist theories of learning [22]. Moreover, they highlight that games offer an appropriate environment for situated learning since they may happen in virtual environments resembling, recalling and representing the real context in which they occur. In this line, Van Eck [14] explains: "What you must learn is directly related to the environment in which you learn and demonstrate it; thus, the learning is not only relevant but applied and practiced within that context…Researchers refer to this principle as situated cognition". (pp.18)

These aspects are key in i-Treasures, in particular the possibility of following a situated learning approach, since the context where ICH is performed has a great importance/value (sometimes linked to its uniqueness).

### *3.2.2 Games support procedural learning*

Games are also widely recognized as potentially adaptive to support the learning of procedures and gestures (and of sequences of gestures, physical actions) and, in this flow, they are also widely adopted in professional training [23],[24]. Examples of this potential are: 1) the game 'Staying Alive' , (developed by iLumens in collaboration with Dassault Systèmes) which trains the procedures to be enacted in case of a heart attack and 2) in the military field, 'DARWARS Ambush' which is focused on teaching soldiers how to react to ambushes and roadside bomb attacks on convoys [25].

Procedural learning is at the basis of the learning and transmission of most ICH considered in i- Treasures.

### *3.2.3 Games are engaging and motivating*

As a matter of fact, research has proved that games promote extrinsic and intrinsic motivation [26] through the setting up of goals and rewards [27] and/or through a narrative context [28]. Games are also engaging, namely they make learners invest effort and commitment in learning tasks [29]. This intrinsic capacity of games to motivate and engage makes the learners interact with them for longer than traditional materials. When learners are

immersed in a game (namely learners are engaged, intrinsically motivated and feel like internal actors in the game application) the learning is stealthy, that is learners are not aware that they are learning the embedded contents [30] and the learning effort diminishes.

Building on these findings, the i-Treasures aim was to offer a stimulating learning environment.

### *3.2.4 Games are able to promote self-regulated learning*

As Zap and Code [31] stated "Video games possess at least eight characteristics that make them ideal environments for facilitating and promoting self-regulated learning. Games are: (1) interactive, (2) repetitive, (3) adaptive, (4) cumulative, (5) scaffolded, (6) affectively situated, (7) intrinsically oriented, and (8) based on both player-centred and game-based goals".(p.738). Furthermore, they provide real time and constant feedback to the player about his/her progress; feedback could be a score but also informative, namely feedback designed to elicit the correct behaviour or action [32]. This of course supports the autonomous learning processes, by giving not just updated information about the level of achievement but also about what the learner needs to do in order to accomplish the task.

The possibility of taking control of one's own learning process and behaviour was deemed to be very important in the i-Treasures case, where learning is generally linked to a personal choice and can also be performed in non-formal/ informal learning contexts.

### *3.2.5 Games support collaboration among the learners*

There are many digital multiplayer games, which are not based on a competitive dynamic. For example, the game named Course sans Gagnant [33] is played in small groups and is a good example of how high school students collaborate for a common final goal. The underlying premise of collaborative games is based upon consensus building through cooperation by group members [34]. We found that positive interdependence dynamics could be generated among the students involved in game-based collaborative learning activities: students need to collaborate with each other in order to achieve their learning goals. In this respect, from multiple experiences it emerged that game-based learning has the potential to enhance collaboration by designing an intra-group dynamic of cooperation and positive interdependence between the team-mates [35].

Since some ICH (e.g. dances, songs) are collective performances, providing learning tools able to sustain students' collaboration is very important in i-Treasures (although the initial learning tasks are often individual).

## 4 DESIGN PRINCIPLES FOR GAME-LIKE APPLICATIONS

Designing an educational game is a very complex task, often involving different people and various competences. In the context of i-Treasures, this is particularly true, because the design and development of each game requires input from different professionals: the experts of the cultural expression at hand, the technical people who are experts on the sensors to be used in the sensorimotor learning module, the technical people who develop the game itself, the educational technologists and methodologists who provide guidance about the educational and pedagogical aspects of the game, etc…The collaborative effort necessary in such cases is demanding; in i-Treasures we have managed it through continuous and recursive interactions among all the people involved.

Many aspects should be taken into account during the design process; some of them are general aspects that should be taken into account in any game, while others are specific and come from the specificities of the ICH domains handled by the project.

General guideline principles, that should be taken into account during the design process, have been provided to scaffold the preliminary interactions among the various actors during the design process, afterwards specific work was done, game by game, in order to tailor each one according to the specific ICH expression considered.

## 4.1 General guidelines and their instantiations in the different i-Treasures games

General guidelines cover several aspects that need to be defined at the very beginning of the design process; guidelines have been grouped into overarching categories. Categories will be introduced in the following sections, accompanied by examples of instantiations in i-Treasures games.

### *4.1.1 Pedagogical aspects*

This category is aimed at guiding people involved in the game creation, in particular the experts of the cultural expression, in identifying and establishing the pedagogical features of the game, starting from the main objectives and the contents to be embedded, up to the playing out of the situation (e.g. task definition and sequencing, educational strategy for each task) (see Tab.1).

**Table 1 – Pedagogical aspects to be considered and defined**

| |
|---|
| **Educational objective(s)** |
| • Provide a list of the intended educational objectives (pay attention to how to express them e.g.: 'the student should be able to…')<br>• Establish the sequence of objectives (if any) |
| **Contents** |
| • Provide a list of contents linked to the educational objectives<br>• Provide details of what has to be taught (task/s related to contents e.g. content - a specific dance figure; task – explain orally the movements needed or perform the movements dancing in front of the screen equipped with Kinect)<br>• Define the possible scenes (multiple scenes for each task)<br>• Associate each task with a specific level of difficulty; produce a list of the foreseen levels |
| **Play out of the situation** |
| • Define the list of tasks per each educational objective (detailing their sequence, the appropriate educational strategy and the specific hardware needed, if any)<br>• Define the educational strategy best suited to each task (e.g. drill & practice or experiential learning or …) and, possibly, the modality with which it is implemented (e.g. group work, individual exercise)<br>• Define the optimal sequence and include possible deviations from the standard (if any)<br>• Define the hardware complements to be adopted during each task (when and how e.g. Kinect use from the beginning |
| **Feedback** |
| • Define the feedback linked to each task by detailing:<br>  o The form/s of feedback (oral/visual/ written/iconic etc..)<br>  o The feedback provision modality (upon request or confirmation/automatic…)<br>• Consider that there is a need for formative feedback (not only summative)<br>• Feedback provision needs to be adapted to the personal needs of each player (codified a priori e.g. oral or written form) and should also be customized based on players' performance as much as possible. |

Of course, given the complexity of the cultural expression, considered as a whole, experts generally identified basic aspects of each ICH to be taught through the game. For each game a sort of game scenario was provided, taking into account the aspects listed above.

For example, the scenario for 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 centring the clay on the wheel, prickling the clay in the middle and forming the bottom of the object, etc). Tasks correspond to different scenes that are instantiated in different game exercises.

### *4.1.2 Game structure:*

This section is aimed at supporting the people involved in designing the game structure, as to the scenes/levels and progression rules, sessions implementation (e.g. training and game session description, presence of formative feedback). Some suggestions about the structure (e.g. dividing the training sessions into "observing" and "practicing" phases) are provided in order to endow games with a common framework (see Tab.2).

**Table 2 – Game structure aspects to be defined**

| **General organization: scenes / sessions and progression** |
|---|
| • Define how the game should be organized: (e.g. based on increasing the difficulty level/ presenting different scenes…)<br>• Define the progression rules (based on which achievements/when one passes from one task to the next)<br>• Typically a game should encompass multiple scenes/multiple levels. Different scenes of the same difficulty (presenting almost the same task) could form a specific difficulty level<br>• Define whether all the levels/scenes must be completely "solved" before proceeding or only to what extent performance is "satisfactory" |
| **Sessions** |
| • Define the sequence of game actions, among which:<br>o Player identification (input of username and password, selection of the name from a specific list...)<br>o Avatar choice/construction (if needed)<br>o Possibility of setting personal parameters and testing the system on specific users' behaviour (see also training phase below)<br>o Enter the game<br>• Training sessions could be subdivided into an "Observe phase" and a "Practice phase", so that the student first looks at correct performances and then reproduces them.<br>• At the end of the training sessions, a final "Challenge" session can be foreseen, where the user performs what s/he has learnt and get a final assessment.<br>• Game instructions should be provided (how to make choices related to specific interface/interaction modalities according pre-determined settings, how to recall instructions during the game, how to access help…)<br>• Formative Feedback should be provided (from which the student may understand exactly what is not satisfactory in his performance), including the possible provision of remedial (different from standard) actions in case of failure<br>• Time out possibilities could be foreseen<br>• Ending/pausing of the game and giving up situation should be managed |

For example, in the game-like application for Tsamiko dance, experts identified the teaching of basic steps on which the dance is based as main goal to be reached. This objective is pursued in the game by proposing a sequence of activities where each activity covers a step; each activity, then, includes a set of exercises (related to moves), that the learner needs to fulfil. The first activity focuses on the simple single step Tsamiko style (10 steps) and includes five exercises while the second activity focuses on the more advanced double step style (16 steps) and includes four exercises [3].

As suggested in the guidelines, each activity was structured in two sessions, an "Observe phase" during which the learner just observes a teacher in a video (or an avatar) showing the move and a "Practice phase" where the learner practices the move. The learner needs to overcome a pre-defined threshold (fixed by experts) in order to

move to another exercise and activity; after having fulfilled the training activities the learner can access a final challenge, where she must demonstrate having mastered the steps learnt (see Fig.1).

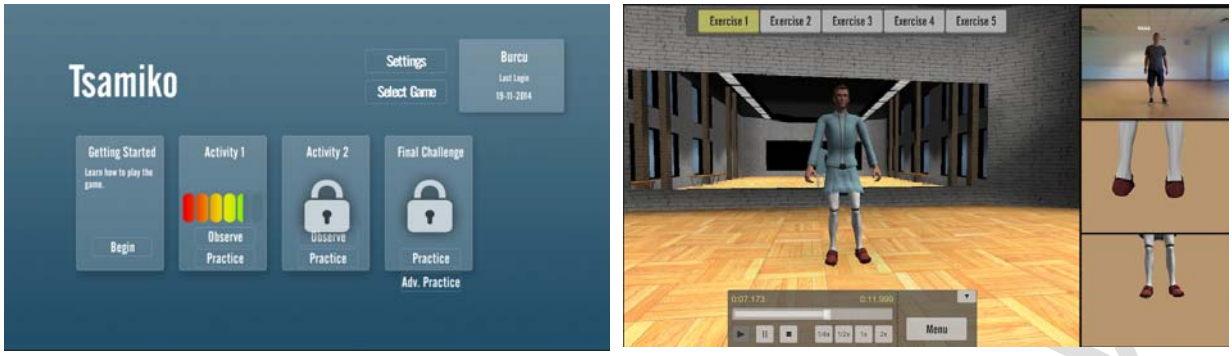


**Figure 1 – Tsamiko dance game: main menu (left side) and "Observe" screen (right side).**

### *4.1.3 Scores and performance evaluation*

The score is a very important aspect in games; this is truer in games conceived for educational purposes where it represents a summative feedback of the overall performance and attainment of the learning objectives. This section of the guidelines is aimed at providing game developers with a meaningful solution for score computation and at triggering a reflection on how the scores should be visualised by the learners (see Tab.3) [36].

**Table 3 – Scores and performance evaluation aspects to be considered**

| **Computation** |
|---|
| • The scores obtained are based on performance in each scene. Maximum score is obtained if one scene is well completed at the first attempt. The score diminishes based on the number of attempts.<br>• Score attribution is the basis for level progression, based on the defined rules (see above) |
| **Visualization** |
| • Define how the scores are visualized during and at the end of the game (e.g. coloured bar, numbers…)<br>• Visualization could also take into account the performance of all players (e.g. those in the same classroom) not only of the student who is presently playing<br>• The system should/could visualize differently the scores obtained for the benefit of player and the educator (for the educator a more complete report might be needed) |

In the current structure of the i-Treasures games, the score computation is different in each game, since field experts provided different suggestions on how to make the most of practicing exercises. The score visualization is, on the contrary, displayed in the same way in all games by means of a colour bar in the main menu while a verbal feedback is provided by a virtual tutor on the practicing screen.

### *4.1.4 Data collection:*

In recent years, data mining and the resulting possibility of analysing them for statistical and educational purposes has attracted more and more attention and this is also true in the field of Serious Games [37],[38],[39].

Generally speaking, there are data that we need to track in the game: some of them are oriented to study the users' behaviour, others are more generally directed to obtain information and study the game usage. Based on the former, it is possible to investigate/assess the performance of each student (which can then be compared so as to obtain a whole view of students' performances and results and, as a consequence, of the game educational effectiveness). Based on data about game usage it is possible to fine tune learning interventions/sessions (e.g. time to be allowed) and, possibly the tool itself (e.g. possibly useless areas, buttons).

Some guidelines provided to the game developers are reported in the table below (Tab. 4).

**Table 4 – Aspects to be taken into account for Data mining**

| **Personal information data about players** |
|---|
| • Player profile<br>• Specific interaction and accessibility (if any) settings required (e.g. need for alternative inputs, need for audio feedback…) |
| **Gaming analytics** |
| • Data on user behaviour, e.g.: time spent on game, time on task, number of game sessions, number of exercises completed, number of trials/exercise (distinguishing between correct/not correct), errors per exercise, score per exercise, final global score obtained, "observe" /"practice" dynamics, help use<br>• Global Data on game use, e.g.: students' profiles, number of users who have finished the game, number of users who have finished each single exercise, mean time spent on each task, mean time spent on the whole game, help usage, etc. |

## 5 CONCLUSIONS

This paper has offered a view of the theoretical rationale that led the i-Treasures project to the adoption of Serious Games to support the learning and transmission of a number of ICH expressions; the main design principles that guided the design of the i-Treasures game like applications have also been outlined. For sure, digital games per se present several assets that make them useful tools to support education in general and also the specific field of ICH. Nevertheless, their adoption in the area of ICH is still very limited (particularly if compared to the area of Tangible Cultural Heritage); this is mainly due to the peculiar intrinsic characteristic of the teaching/learning process of Intangible cultural expressions, essentially based on oral tradition and imitation. Making use of advanced ICT and sensor technologies it was possible to analyse and model the cultural expressions considered, and, on this basis, to build up game like applications supporting their teaching and learning. This design process required a collaborative effort of all the actors involved (experts, game designers, educational technologists and partners in charge of data capture and analysis) and also required following shared guidelines and design principles. So far, four games have been developed. Given the high level of specificity of ICH, the process, although based on the general guidelines described in this paper (which were aimed at ensuring a common understanding and at guaranteeing increased educational effectiveness) very soon called for hard work of adaptation of each game to the specific characteristics of each ICH. This overall procedure turned out to be challenging and laborious, but also resulted in being quite effective to support collaborative design work and both contents and methodologies can be productively re-adapted to similar future endeavours.

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