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ORIGINAL ARTICLE

Innovative technologies for intangible cultural heritage education and preservation: the case of i-Treasures

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Abstract The recent technological development has opened up innovative scenarios in the field of intangible cultural heritage (ICH) education and preservation. Main aim of this paper is to present a study, whose objective was to investigate whether and to what extent technologies can play a role in the ICH preservation and education. The study was conducted in the context of i-Treasures, a project funded by the European Community. During the project, a platform has been created, which provides different types of services that can meet the demands of different types of users in the ICH education domain. In the paper, the process followed for the implementation of such platform is described, starting from the analysis of the user needs, down to the development of the various innovative features. These encompass not only informative functionalities but—even more importantly—features allowing sensorimotor learning experiences for the user, who—by wearing innovative sensors—can practice rare forms of dancing or singing and get feedback about the correctness of the performance. The paper presents the methodology and findings of the user evaluation and then points out the main strong points and weaknesses of using innovative technologies in the ICH preservation and education.

Keywords Intangible cultural heritage (ICH) · Education · Preservation · Platform · User requirements · Motor learning · Sensors

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1 Introduction

This paper addresses a peculiar area of the cultural heritage, namely the intangible cultural heritage domain. The concept of "intangible cultural heritage" (from now, on ICH) "includes traditions or living expressions inherited from our ancestors and passed on to our descendants, such as oral traditions, performing arts, social practices, rituals, festive events, knowledge and practices concerning nature and the universe or the knowledge and skills to produce traditional crafts".[1]

In 2003, the United Nations Educational, Scientific and Cultural Organization (UNESCO) issued the Convention for the Safeguarding of the intangible cultural heritage[2] to protect "the practices, representations, expressions, knowledge, skills—as well as the instruments, objects, artifacts and cultural spaces associated therewith—that communities, groups and, in some cases, individuals recognize as part of their cultural heritage" (art. 2, Convention).

In doing so, UNESCO recognized that ICH needs a different granting approach from the one adopted to maintain and preserve tangible ones (like monuments, sites) that is usually based on a state-center approach; indeed, in the case of ICH, it is necessary primary to involve the performers' communities in the protection of their traditions [1].

Recently, the rapid and progressive improvement of technologies has opened new ways to go in the preservation of ICH, as they potentially allow new kinds of user interactions, potentially going beyond the encyclopedic

[1] http://www.unesco.org/culture/ich/en/what-is-intangible-heritage-00003.

[2] http://www.unesco.org/culture/ich/en/convention.

approach that has characterized so far most of the ongoing projects aimed at ICH safeguarding.

While in the tangible cultural heritage domain, a number of studies have already pointed out the potential of technology to create innovative learning environments [2–4], in the ICH sector, the number of studies related to the potential of technologies for teaching and learning is very limited.

To fill in this gap, the authors have devoted their attention to study whether and to what extent technology can play a role in ICH preservation and education. The results of this research are presented in this paper, which describes in particular the experience carried out within i-Treasures, a European project started in 2013. The project aimed to design and develop an online platform, to preserve and pass down some intangible and rare arts. As it will be described in the following, the platform provides different types of functionalities devoted to various types of users of the ICH domains. It is important to note that—differently from other existing projects—i-Treasures does not address one single artistic expression, but rather deals with four different areas of ICH, namely: rare traditional singing, rare dance interactions, traditional craftsmanship and contemporary music composition. Thus an important added value of i-Treasures is that the main results of the project have got not only an impact at the level of one ICH, but have potentially a wider impact on several ICH domains and have got great potential for transferability. Another added value of the project, in line with what was suggested in the 2003 Convention, is its ability to involve in the overall design process the communities of experts and performers of the ICHs at hand.

In the following, the paper presents a section about the existing work and literature in the field, followed by a section that presents the context of the i-Treasures project: Here a classification of the users and their needs is also introduced, and the process followed during the project to build the platform for the ICH transmission and preservation is illustrated. The subsequent section describes the i-Treasures platform, and then data are presented deriving from the user evaluation of the platform. The paper ends with a discussion of the data that shed light on the strong points and weaknesses of the platform itself, as well as on the process that led to its development. This way, in the conclusive section, we will reflect on the main lessons learnt from this experience and identify threads for future work in this emerging research line.

2 Background and related work

UNESCO can be considered the main guardian of the world cultural heritage. As already mentioned, in terms of ICH, the 2003 Convention is the main normative document regarding the protection of these traditional artistic expressions. It defines the main intellectual and operational steps to be followed by national governments and at international level, to protect intangible heritage.

In the last two decades, UNESCO has supported several projects in order to preserve ICH. However, most of these projects had as ultimate goal to build repositories of information expressed in an encyclopedic way, rather than to foster the actual passing on and learning of intangible traditions. This can be related to the fact that the 2003 Convention recognizes registers and inventories as a first step for safeguarding intangible heritage. In these projects, even when technologies are adopted, these have merely an archival purpose [1].

In other very few cases, technologies have started been adopted for supporting teaching and learning of less rare cultural expressions (like modern dancing or playing musical instruments) [5–8]. Even in these contexts, though, technologies mainly take the form of learning management systems where multimedia materials are stored for study; in some cases, communication tools are also made available to allow discussion among learners and with teachers. Recordings of performances and annotated video tools are occasionally integrated to support teaching/learning activities [5–8]. To the best of our knowledge, though, none of these studies envisage the direct involvement of learners in practicing one artistic expression [5].

With the recent improvement of available technologies (such as sensors), though, it is becoming clear that technologies can in principle play a completely different role and open up innovative educational scenarios; for example, the user could wear sensors and his/her performance can be "captured" in such a way that s/he gets feedback about the correctness of the movements. This is what happens; for example, in some of the most popular games available on the market, where the user—by wearing motion sensors—can experience sport playing, action gaming, dancing, etc. Usually in these contexts, the main goal is fostering users' leisure and engagement, rather than teaching and learning.

The case of i-Treasures represents a novelty because the motor sensors are used to capture, analyze and model the complexity of rare intangible performances with educational purposes [9]. A similar approach was adopted in 2008 in the context of the i-Maestro project,[3] where sensors were used to teach and learn musical skills [10]. In i-Treasures, this is done in different ICH domains and—for some of the ICHs considered—given that no sensors were available on the market, and the project has developed ad hoc sensors and has used them to support learning of these expressions.

[3] http://www.i-maestro.org.

3 The context and the user needs analysis

As already mentioned, i-Treasures[4] is a project funded by the European Community, making an extensive use of cutting edge ICT and sensor technologies, with the aim of developing "an open and extendable platform providing access to ICH resources, enabling knowledge exchange between researchers and contributing to the transmission of rare know-how from living human treasures to apprentices" [11].

Thus, the main aim of i-Treasures is to provide new methods, and employ and create innovative tools, to pass on rare ICH knowledge to new generations. To do so, in the project we first "captured" the key aspects of the different ICHs by tracking expert performers wearing sensors. Then we applied modern techniques of semantic multimedia analysis and built "models of performances", thus providing the widest range of information ever had at least for some of the intangible expressions considered. This wealth of information can respond to various scopes and educational needs and could be used to propose different learning and teaching paths. This can take the learners beyond the concept of "learning ICH by imitation", giving the possibility to have multimodal and multisensory learning experiences, carrying out individual trials and receiving appropriate feedback. In this way, the learner can improve his/her level of competence in an easier, more direct, quicker and effective way [12].

As already mentioned, i-Treasures tackles four different areas of ICH:

- Rare traditional singing;
- Rare dancing interactions;
- Traditional craftsmanship;
- Contemporary music composition.

Each of the previous ICH domains was instantiated in different examples, as it is shown in Table 1. In the table, the first column contains the main areas of intangible cultural heritage; the second column shows the list of examples of ICH considered by the project; the third one contains the original country of the ICH.

In order to design and develop the i-Treasures platform, the project started from a user need analysis. Potential use cases for the platform might range from providing "low level" information for the generic user, who simply wants to know more about one (or more) ICH, to offering complete educational paths for another user, who is deeply interested in learning how to perform one artistic expression.

In particular, depending on the kind of information, a user might expect to find on the i-Treasures platform, and it is possible to divide users into four different categories (see Table 2).

As it is shown in Table 2, a basic user from the public may have got a generic interest in one or more ICH: S/he needs to find "basic" information about the cultural expression and possibly to be adequately supported in searching this information. Data about the ICH origins, its current geographical location, its basic features, etc., are examples of data a basic user may want to look for and find on the i-Treasures platform. These kinds of needs are labeled *informative*.

A scholar, an expert or a teacher of one ICH, will also need to find information, but he will need data and contents of a different kind, able to support research and deep study of one specific phenomenon. Recorded data of performances and raw data tracked by various sensors are examples of data an expert may be interested in. These kinds of needs are labeled as *research/enquiry needs*.

As far as the learner is concerned, it is possible to distinguish between a learner who needs to know more about one specific cultural expression at a theoretical level (*cognitive learning needs*) and an apprentice, i.e., a learner, who wants to acquire/improve her performing skills (*motor learning needs*).

While the former type of learner will need information and data about the ICH, structured in such a way to support an effective learning process, the latter one will also need the platform to support a motor learning experience through other kinds of features, such as the possibility to observe and perform the ICH, be recorded, and possibly get feedback regarding the correctness of the performance.

In line with the most common guidelines for designing a software product, the process of definition of the platform user requirements started from the four types of needs identified above [13] and then involved a number of stakeholders to understand their needs and to decide with them which functionalities the system should be able to offer [14]. Thus in the project, we took a *participatory approach* that was based on a close collaboration with and among all the stakeholders [11]. In order to collect data and information from the users, we organized focus groups and workshops and used interviews and questionnaires, thus following more ethnographic approaches based on the direct observation of the users' actions/needs [15].

Basing on this huge corpus of data, we defined the preliminary list of requirements, that was subdivided in five different functionality areas (Information, education and research; Educational process; ICH capture and analysis; Data fusion and semantic analysis; 3D visualization for sensorimotor learning), responding to the categories of user's needs identified above (see Fig. 1). In particular, the informative and enquiry/research needs are addressed by the functionality called *Information, education and*

[4] http://www.i-treasures.eu/.

Table 1 ICH examples in i-Treasures' platform

ICH area	ICH	Country
Rare traditional singing	Canto a Tenore	Sardinia (Italy)
	Cantu in Paghjella	Corse (France)
	Byzantine hymns	Mount Athos (Greece)
	Human beat box	Worldwide
Rare dancing knowledge	Càlus dance	Romania
	Tsamiko dance	Greece
	Walloon traditional dance	Walloon (Belgium)
	Contemporary dance	Worldwide
Traditional craftsmanship	The art of pottery	Worldwide
Contemporary music composition	Based on music patterns of Beethoven, Haydn or Mozart	Worldwide

Table 2 Classification of users and users' needs

User	Need	Type of need
General public	Needs to find information of different ICHs	Informative needs
Scholar	Needs to find elements to support deeper understanding and research	Enquiry/research needs
Learner type 1	Needs to acquire knowledge about the ICHs (theory)	Learning needs (cognitive level)
Learner type 2	Needs to acquire performing skills and practical competences	Learning needs (motor level)

research, through which the system allows the user to access generic and basic information about the various ICHs (for the general public) and raw data and scientific materials (for scholars and researchers).

To address the cognitive learning needs, the system has been featured with a functionality called "Educational process", through which the user is purposed structured learning paths through a learning management system, enriched with ad hoc learning materials and specific educational activities for each ICH.

Lastly, in order to allow motor learning, the system is featured with three distinct functionalities: "ICH capture and analysis" (to capture the user's performance); "Data fusion and semantic analysis" (to analyze and fuse the captured data); "3D visualization for sensorimotor learning" to give feedback to the user about his/her performance.

In Fig. 1, a synthetically map is provided, representing the relationships between system functionalities and users' needs.

The requirements definition process was iterative and encompassed a later stage of requirements revision, based on the evaluation of the first prototype of the platform [16]. During that stage, in line with the approach already taken to define the original requirements, we again followed a systemic and participatory approach. The process encompassed the analysis of the current level of accomplishment of the original requirements and their check against the users' perceptions/opinions. The results of this phase were the definition of a new list of revised and updated requirements [13] which were then used to develop the final version of the platform presented in the following section [17].

4 The i-Treasures platform

The following schema (Fig. 2) illustrates the i-Treasures platform architecture.

In synthesis, the system incorporates a distributed approach, meaning that not all the data generated by the capturing and processing modules are stored centrally in one large database. Indeed the i-Treasures platform comprehends two different repositories that are developed with different aims: In particular, there is a local repository (that is the Web sites of users or content providers) where the raw recordings and low level features are stored and a central repository (that is the main i-Treasures' Web site that lies on a relational database) that contains the medium-level features that are then processed in order to extract high-level features and metadata allowing the repository not only to be more lightweight and efficient, but also to

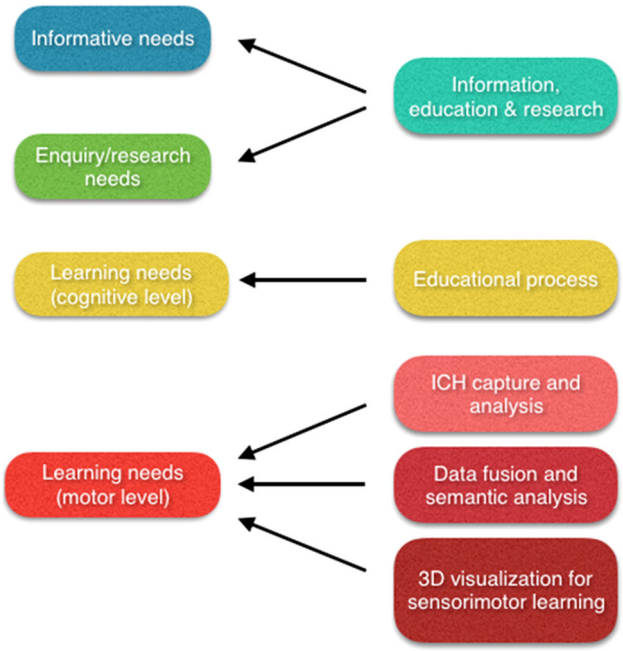

Fig. 1 Requirements' classification and user needs

remove the need for transferring large data sets over the network, significantly reducing the associated infrastructure, storage and bandwidth requirements [17].

In line with the requirements defined as illustrated above, the i-Treasures platform was realized with the aim to satisfy all the different categories of user's needs [18].

For example, in order to respond to the informative needs, the system is able to give access to general information and materials to users. For each domain and for each ICH, the system provides a list of informative pages, where the user can find a number of encyclopedic and theoretical information, regarding, for example, historical or geographical aspects. A collection of the pages that contain those kinds of information is shown in Fig. 3.

In order to satisfy the enquiry/research needs, the platform is able to provide selected access to raw data and scientific materials to users. Thus, the platform provides a list of multimedia files for each ICH, where the user can navigate using also a precise metadata search and can get detailed information regarding the "correct" performance of one intangible heritage. In Fig. 4, there are some illustrative pages about the Tsamiko Dance.

As far as the learning needs at cognitive level are concerned, the system is able to propose structured learning paths to the user according to his/her needs. Indeed, i-Treasures platform offers a learning management system where the user can follow a complete course about the chosen intangible tradition and can navigate through different lessons composed by combinations of textual, audio and video resources and learning activities and structured according to increasing levels of complexity. In Fig. 5, an example of some lessons contained in the course of Canto a Tenore is proposed.

Fig. 2 i-Treasures' platform: system architecture

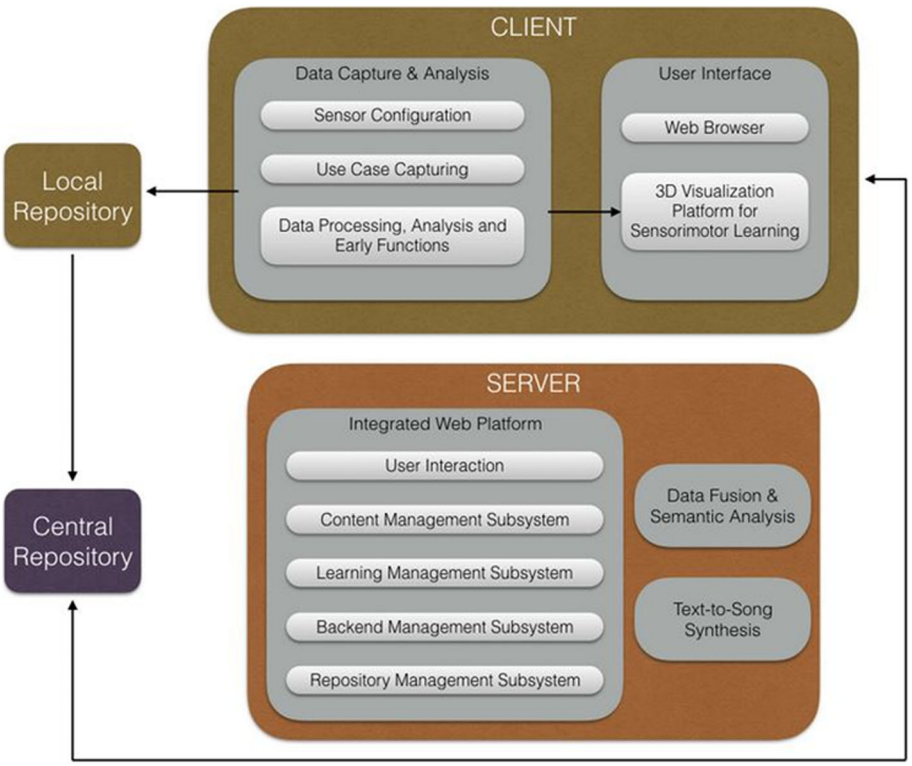

Fig. 3 i-Treasures' platform and informative needs

In the end, as far as learning needs at motor level, the system is able to capture the user's performance—provided that the user is wearing the appropriate sensors; then the system can fuse the captured data to make the semantic analysis and give a feedback to the user regarding the quality of his/her performance. This is what happens in the 3D visualization functionality for sensorimotor learning, where the user can make direct and immersive experience of the intangible culture. In particular, through such functionality, the user is proposed two different learning modes: the "Observe" mode and the "Practice" mode. In the Observe mode, the user can observe the performance of an expert, while in the Practice one, s/he can reproduce the expert's performance, getting appropriate feedback from the system about the level of correctness of her/his execution. As an example, in Fig. 6 you can see the interface of the *Observe* mode in the Tsamiko dance 3D functionality. Here the user can observe the 3D avatar of the expert in action in the main window, while the three little windows on the right side contain a video clip of the real performance of the expert and two focusing on the legs of the avatar of the expert: The first one is proposed by a backwards prospective, while in the second, the prospective is given by a front camera.

Figure 7 presents the *Practice* mode of the same functionality for the Tsamiko dance: Here the main window keeps showing the 3D avatar of the expert, and in the top window of the right column, there is a video clip of showing the real performance of the expert. In the middle window in the right side, there is the avatar of the user, while in the bottom window there is a backwards prospective of the legs of the avatar of the expert [19].

To give another example of this functionality of the i-Treasures platform, which is the most innovative one, in the following, we also present the 3D environment for the singing traditions. In Fig. 8, for example, we can see a user wearing the sensors specifically developed by the project (called hyper-helmet) to record the singer's performance

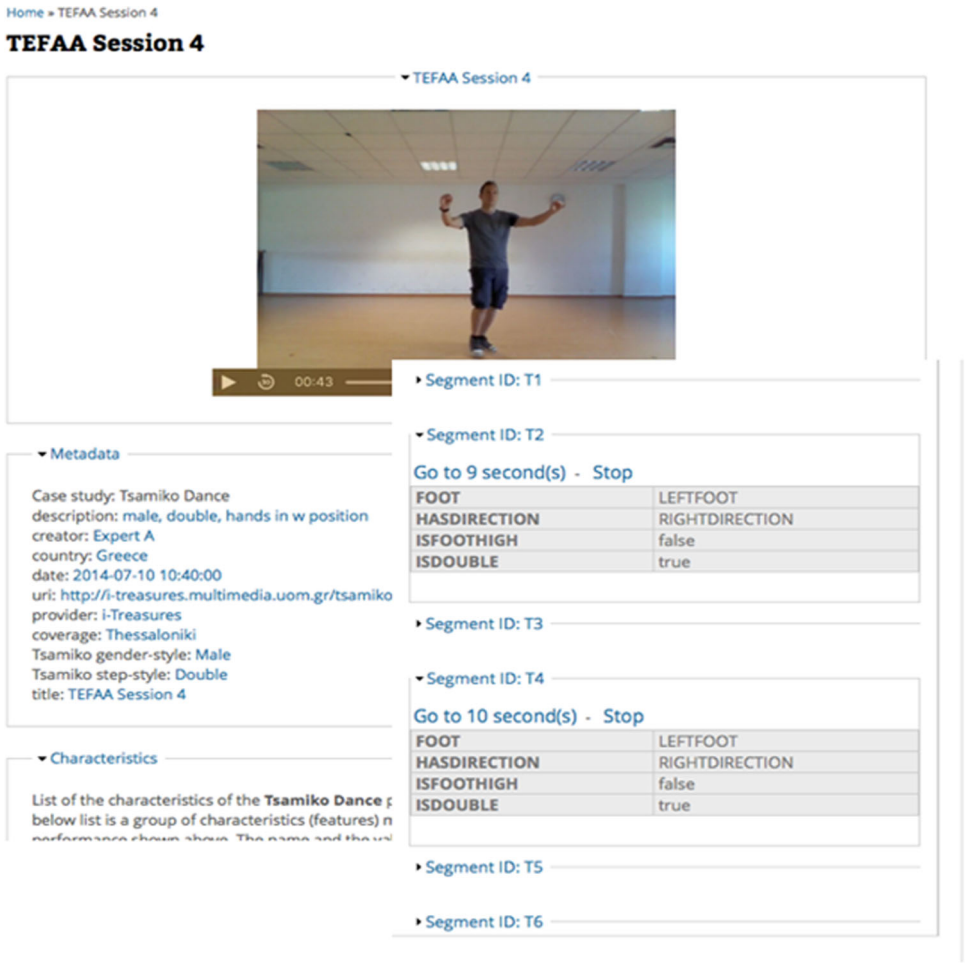

Fig. 4 i-Treasures' platform and enquiry/research needs

and interacting with the 3D functionality of the platform [20]. In this case, the data acquisition system is able to synchronously record ultrasonic and video data at sufficiently high frame rates to correctly characterize the movements of the tongue and lips, as well as the acoustic speech signals, the electroglottograph, the accelerometer and the respiratory waveforms [21]. Thus, this functionality of the platform allows the user wearing the hyper-helmet, to try to sing following the expert's sample—and getting appropriate feedback through a score determined by the accuracy of her/his performance.

5 Platform evaluation

The i-Treasures platform has been evaluated by hypothesizing the ICH operational model presented in Fig. 9, indicating that "design", "learning management system" and "platform characteristics" serially mediate the relationship between "information" and "performance". Each "box" in this model refers to a general construct, which is constituted by "dots" referring to sub-constructs. The relationships that may exist between constructs are presented by "arrows". Constructs, sub-constructs and relationships have been proposed by experts, thus, verifying content validity. Considering that the model refers to perceived constructs, it is further assumed that controls (e.g., users' gender, age, level of education, and familiarity with computers) may influence the information—performance relationship [10, 16].

For testing the operational model and accordingly evaluating the platform, data were collected in March 2015, with the help of 43 individuals responding to a questionnaire, following a specific protocol (e.g., establishing meaningful relations with local communities; creating accounts for all users involved; workshops including demonstration, use of platform according to instructions, explanation and completion of questionnaires). All items were measured on a scale ranging from 1 = not at all/very bad to 5 = very much/very good. Examples of the items included: purpose, "How clearly the scope of the website is stated?"; navigation, "How possible is to know where on the web platform are you at each time?"; searching within LMS, "How easy it is to

Fig. 5 i-Treasures' platform and learning needs at a cognitive level

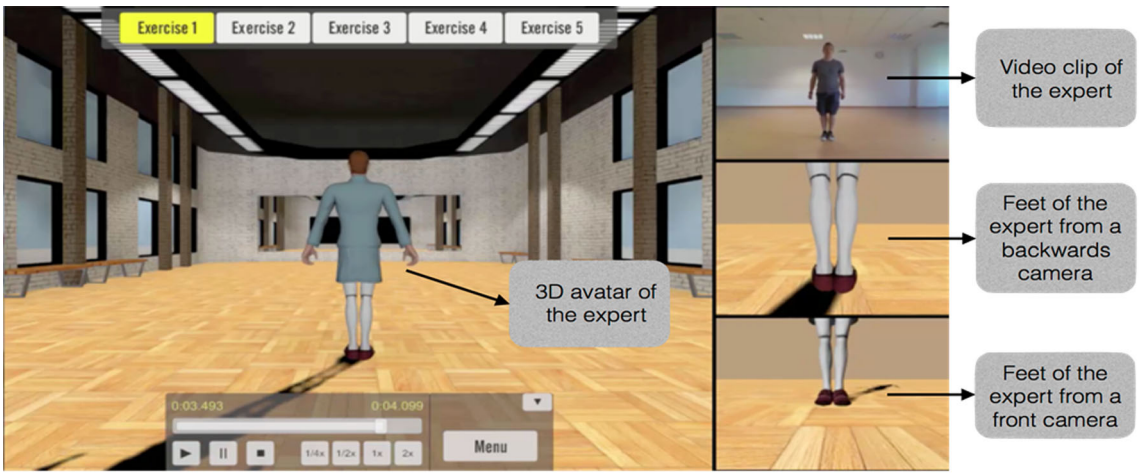

Fig. 6 Interface of the observe mode in the Tsamiko dance 3D functionality

search for information in a course of a thematic module in LMS?"; complexity, "How complex do you consider the web platform to be, in helping you to understand the issues it is presenting?"; effectiveness, "Does the website meet its objectives?"; and efficiency, "Does the website use the fewest possible resources to meet its objectives?"

Before estimation of the operational model the survey instrument was examined with respect to construct internal

Fig. 7 Interface of the Observe mode in the Tsamiko dance 3D functionality

Fig. 8 Example of interaction with human beat *box'* functionality wearing hyper-helmet sensor

consistency, construct validity, construct composite reliability, construct discriminant validity and common method bias [22]. To test the proposed framework, the methodology of structural equations models, or latent variable models [23], was used via the statistical package of SPSS–AMOS. The estimated path diagram for the proposed framework is presented in Fig. 10. The circles represent the related latent variables, and the bold arrows indicate the structural relationships between the corresponding variables. The numbers that are assigned to each arrow show the estimated standardized coefficients. The goodness-of-fit indexes confirmed the validity of the operational model (p value of Chi-square =0.014, normed Chi-square =1.278, root-mean-squared error approximation = RMSEA = 0.081, normed fit index = NFI = 0.719, comparative fit index = CFI = 0.917, goodness of fit index = GFI = 0.728) [24].

Taking into consideration the limitation of the small sample size, the results highlight that:

- The model rather acceptably predicts performance (all standardized coefficients are significant and have the

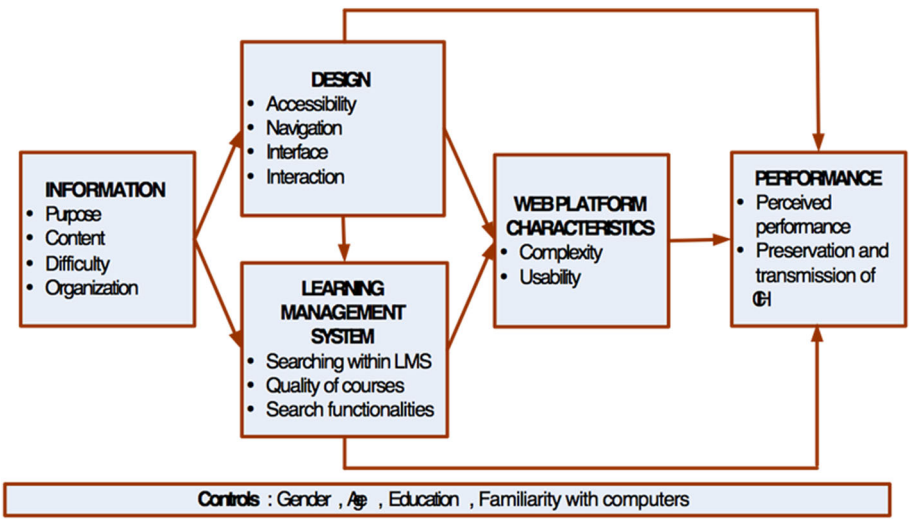

Fig. 9 Operational model for evaluating the i-Treasures platform

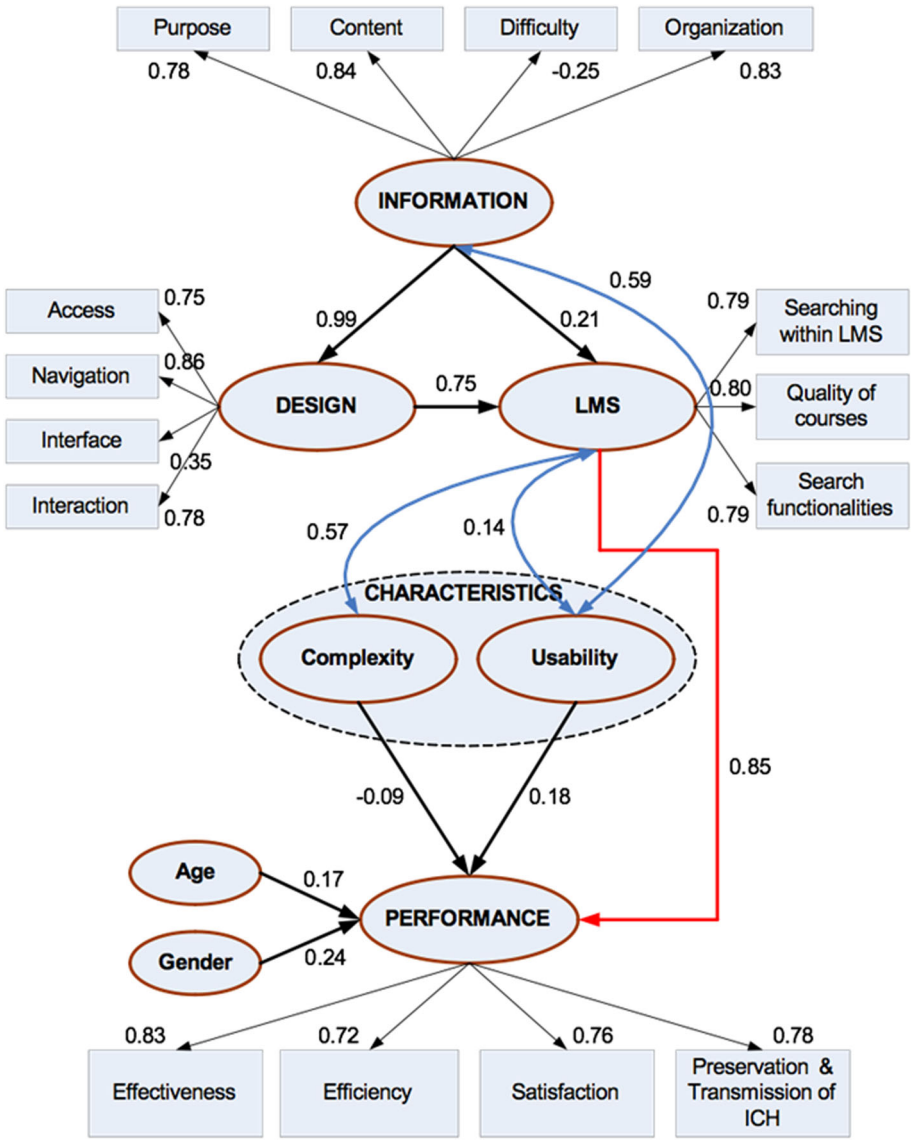

Fig. 10 Operational model for evaluating the i-Treasures platform

appropriate signs, and the fit indices are in large acceptable).

- Design and LMS fully mediate the relationship between information and performance.
- Design partially mediates the relationship between information and LMS.
- The "difficulty of the informational content" and the "complexity of the platform", have a negative influence on "performance".
- "Content" and "organization" are the most important informational factors that predict performance.
- "Navigation" is the most important design factor that predicts performance.
- The three LMS factors (i.e., searching within LMS, courses quality, searching functionalities) are equally important in influencing performance.
- "Complexity" and "usability" are two characteristics of the platform that the first negatively and the second positively influence performance.
- "Effectiveness" and "preservation and transmission of ICH" are the most important factors in determining performance.
- Performance is influenced by the demographic characteristics of the users such as age and gender. This means that the platform belongs to the so-called "Contingency Systems", which support the view that the system maximizes its performance according to the specific context within which it is operating [25].

Having established that the results presented in Fig. 10 were acceptable, they were used in estimating the standardized total (direct and indirect) effect of each component of the platform on performance [26]. A summary of

this contribution is presented in Fig. 11, where the left part presents a "diamond type figure", where the outer (blue) polygon reports the means of each component (at a five-level scale), and the inner (brown) polygon reports the loading of each component in contributing to performance; the central part refers to the level of the prediction accuracy of the relationship between the components of the platform and the dimensions constituting the performance of the platform; and the third part presents a "histogram type figure", where the lower (blue) part reports the means of each dimension of the platform performance, and the upper (brown) part reports the loading of each dimension in contributing to the overall platform performance.

According to the results presented in Fig. 11, the major conclusions with respect to the platform are now summarized:

- The components of the platform predict performance with very high accuracy (91.9%).
- The perception of the dimensions of the platform performance ranges between 3.42 and 3.56 (at the five-level scale), indicating that performance of platform is above average.

Additionally, considering the values in Fig. 11, where a low mean of a variable means that there is "room" for the corresponding component to be improved, and a high loading (contribution) of a variable means that the corresponding component is important in determining performance, and the General rule, or "component ranking index", indicating that "the lower the ratio of the mean of a component by its loading is, the higher the priority for changes/amendments for this component", the results presented in Fig. 11 guided the designers of the platform to put effort in further improving the various entities of the system in order to get better results, as perceived by the users of the system. According to the component ranking index, the priority for improvement of the components of the platform in a descending order found to be as follows: complexity, usability, design, learning management system and information. However, any amendment should take into consideration the cost-benefit analysis of each change.

6 Discussion

In the paper, we have investigated the potential of technologies in the process of ICH preservation. We have explained that the state of the art in this research topic is very poor and is mainly constituted by systems that provide repositories or collections of information. Then we have presented the i-Treasures project and its platform that are one of the first attempts to go beyond the encyclopedic approach that has so far dominated the ICH preservation field.

As already pointed out, the project has also the added valued of addressing several different ICH areas at a time, thus covering a broad variety of cultural expressions, instead of focusing on one single tradition. In the paper, we have described the way the platform has been designed through a participatory approach. The process has been highly collaborative and interdisciplinary, with a strong effort devoted to involve all the main stakeholders, including not only the various partners with their variety of competences, but also the communities around the single ICHs considered by the project.

The effort, oriented to define the main user needs to be satisfied by the platform, has given very good results, in terms of ICH analysis and knowledge domain definition, which have then nurtured the process of requirements' definition. From this perspective, the process of knowledge domain definition with the direct involvement of the experts/performers can be considered an outcome of the project in itself.

As far as the resulting platform, to the best of our knowledge, this is the first example of a "complete" system aimed to document and preserve ICH, where "complete" refers to its ability to meet different user needs, ranging from informative, enquiry/research and learning

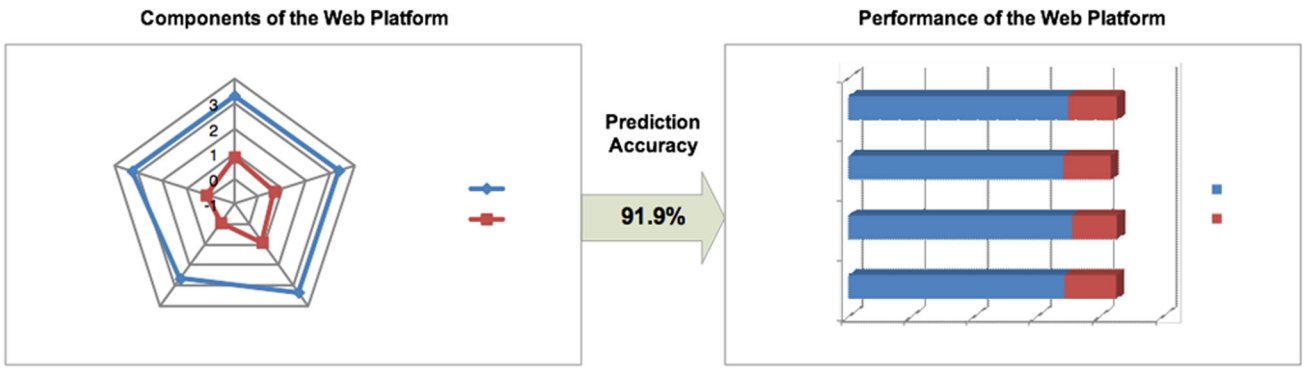

Fig. 11 Relationship between components of platform and its performance

needs (both at cognitive and motor levels). This is very important because in evaluating the platform we saw that the platform performance is not only influenced by the structure of the various components of the system, but it is further influenced by the demographic characteristics of the users, thus, treating the platform as a contingency system, which maximizes its performance according to the specific context within which it is operating.

In particular, as far as the informative area of the platform is concerned, at the moment the i-Treasures platform is able to provide basic information about the ICHs addressed by the project. This is verified by the results presented in Fig. 10, where content and organization are the most important informational factors that predict performance. From the point of view of innovation, this is the least innovative feature of the platform, as other informative repositories already exist, but these are often oriented to one single artistic expression. From this point of view, the i-Treasures platform acts as a hub or unique access point to other existing ICH resources. In fact, considering further the results in Figs. 10 and 11, it is clear that the platform performance dimensions of efficiency and the i-Treasures platform as a means for promoting and preserving ICH expressions got the highest scores.

As far as the enquiry/research area, the platform offers a certain amount of data to researchers and experts in the various ICH fields. These are based on the numerous recordings of experts' performances that occurred during the project that are now available for anyone who wants to have a deep insight into one (or more) of the ICH. To be noted, that while for the dances, we captured basically the performers' motions, as far as the singing is concerned, also internal organs have been captured (e.g., vocal tract, nasal cavity) and this constitutes (at least for some of the ICH) the first time data of these kinds are collected and analyzed. State-space methods of analysis have been used in analyzing parts of these data [27]. All these data have been stored into the i-Treasures repository, which is public and open. The i-Treasures repository is built in line with the EUROPEANA metadata schema,[5] as this is the most well-known portal for cultural heritage; unfortunately, EUROPEANA proposes limited functions concerning intangible cultural heritage, so further work needs to be done to improve these aspects of the platform.

As far as the educational functionalities of the platform are concerned, here is where most of the effort has been done during the project and where the most innovative outcomes have emerged. In particular, the learning paths designed and tested during the project are certainly one of the most important legacy of i-Treasures, especially because they are able to cover both cognitive and motor learning. To be noted that again in this case, for some of the ICH considered, this is the first time formalized learning paths are proposed, as in most cases no schools or teachers exist and the passing down of these expressions is often implicit and based on initiation. In our platform, instead, it is possible to make a direct experience of Tsamiko dancing or Human Beat Box singing and get feedback about the correctness of the performance, by also getting information about what should be changed or improved. This is depicted in Fig. 10 of the estimation results, where the learning management system is directly influencing performance with a high standardized coefficient equal to 0.85.

Of course there are still limitations in the functionalities offered by the platform; for example, when one comes to the polyphonic singing (i.e., Canto in Paghjella or Canto a Tenore), building the 3D environment is particularly challenging and the complexity of the Canto is so high that managing and visualizing the data is still an issue.

Finally, as far as the overall evaluation of the platform is concerned this research offers an innovative and dynamic evaluation method, where evaluation is not restricted on the static elements of the data collected by questionnaires, but goes beyond and proposes a structural equation methodology, where the performance of the platform is evaluated by the components that constitute the platform and by the relationships that exist between these components. Additionally, to the best of our knowledge, this paper proposes for the first time the "component ranking index" seen above, which by simultaneously using the results of the descriptive data of the questionnaires and the dynamic relationships between the latent variables estimated by structural equation modeling it offers a methodology that can be followed by designers in improving components of the platform.

7 Conclusions

Presently the final version of the i-Treasures platform has just been released and further in-field experiments and trials with actual users and within several communities are still underway. Nonetheless, considering the evaluation carried out so far, we have already preliminary positive feedback about the effectiveness and usability of the platform [16]. The results of the data point out that the platform is generally welcome and appreciated, even if some of the functionalities still need to be improved or enriched. Furthermore, the proposed evaluation methodology offers paths for updating, through the component ranking index, entities of the platform at "macro-level" (i.e., specific components in the platform), "meso-level" (i.e., specific dimensions in each component in the platform) and

[5] http://europeana.eu/.

"micro-level" (i.e., specific items in each dimension in the platform). So, even if there is still a lot of work to do in the field of ICH preservation and education, for sure i-Treasures has paved the way to innovation in the field, by proving that technologies can play a crucial role, especially in terms of teaching and learning processes, rather than as mere repositories.

As we have discussed in this paper, the project has also explored the possibility to capture the artists' movements and performances using ad hoc sensors. In these particular cases, of course there is still room for further research, especially to improve usability and exportability of these sensors, but at least at prototypal level—i-Treasures has proved the feasibility of using these kinds of technologies to support teaching and learning processes in the field of ICH.

Overall, the evaluation exercise of the platform indicates that i-Treasures is providing a valuable contribution in the preservation and transmission of intangible cultural heritage and is innovative and it is a useful tool to be adopted by organizations/schools/institutions to help them promote endangered ICH expressions.

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