

Going beyond preservation: how to support technology-enhanced learning in ICH education

Pozzi F., Alivizatou M., Dagnino F. M., Ott, M.
[pozzi, dagnino, ott]@itd.cnr.it; m.alivizatou@gmail.com

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Abstract

The issue of protection and promotion of cultural heritage has become a central topic of European and international cultural policy, especially in recent decades. Beside more ‘tangible’ cultural manifestations (like archaeological sites, natural parks or museum collections) there is a huge heritage, made up of intangible live expressions like performing arts, social practices, oral traditions, etc. which is threatened by the globalization process. The i-Treasures project looks at some of these intangible cultural expressions with the aim not only of preserving them, but also of providing innovative solutions to education in this field. In order to do this, the project explores the potential of cutting-edge technologies for capturing the specificities of the considered Intangible Cultural Heritage (ICH) expressions, analyzing and modeling data and making these resources available for preservation, research and educational purposes. With this aim an open and extendable platform is developed in the project framework. This paper deals with the process of user and system requirements definition and explains how this was necessarily influenced by the specificities of the ICH expressions considered. This process encompassed the identification of the specificities of rare traditional know-how, the discovery of the existing teaching and learning practices and finally the identification of the most cutting edge technologies able to support innovative teaching and learning approaches to ICH.

1. INTRODUCTION

Nowadays preservation and safeguarding of Cultural Heritage have become priorities in many national and international programmes; in particular, the field of Intangible Cultural Heritage (ICH) preservation is gaining resonance and importance. In the last few years a lot of work has been done in this area and if one takes a close look at the concrete experiences in this field, s/he may see there are a lot of projects, most of which take an archival approach, meaning that their outcomes often take the form of digital archives or inventories of materials, aimed at documenting the cultural expression at hand. This aspect, which is certainly of paramount importance, runs the risk of having a limited impact on real preservation, and some of the ICH, especially the rare ones, are still at risk of disappearing.

The advent of innovative technologies can help to go beyond the encyclopaedic approach. The i-Treasures project, by assuming this latter perspective, aims to develop an advanced platform for ICH preservation and education. The challenge for the project is how to design such a platform, given that the specificities of the various cultural expressions considered by the project impose particular needs, thus seriously affecting the design.

By drawing on the experience of i-Treasures, the paper illustrates how the process of requirements definition has been strongly driven by the specificities of the cultural expression(s) the platform is going to support. The paper thus, after reporting on what already exists in the field through a state of the art review on the main projects, explains how the main features of certain ICHs have impacted on the design of the platform, whose aim is to foster innovative teaching and learning processes in the ICH field. The comparison with what has already been done in the field will make the added value of the i-Treasures’ goals and the complexity the project is dealing with

evident.

2. STATE OF THE ART REVIEW

UNESCO is widely regarded as the guardian of world cultural heritage adopting legal measures and raising awareness about humanity's heritage. In terms of intangible heritage, the key normative instrument of UNESCO is the 2003 Convention [1]. This is a legally binding document that offers an intellectual and operational framework for the protection of traditional expressions by national governments and on an international level. It proposes a structured approach that highlights the urgent need to preserve traditional culture through the establishment of national and international inventories, raising awareness and community participation [1].

Over the course of the last decades, UNESCO has developed several projects, which have been directly or indirectly related to the safeguarding of intangible heritage [2]. The most prominent measures have been the two Lists envisaged by the 2003 Convention: the International List of the Intangible Cultural Heritage of Humanity and the List of Intangible Cultural Heritage in Need of Urgent Safeguarding. These are international inventories of traditional expressions. Both are accessible online and include photographs and audiovisual recordings of cultural expressions. Their primary function is that of an archival resource that raises awareness about the listed expressions and their communities. In the case of the List of Expressions in Need of Urgent Safeguarding, it also includes financial support for the adoption of cultural revival measures. The drawback of the lists is that they seem to be serving primarily promotional objectives rather than activities that have a direct impact on local communities [3]. Moreover, the amount of documentation available online is relatively limited.

Prior to these lists, UNESCO supported the programme for the Proclamation of Masterpieces of the Oral and Intangible Heritage of Humanity [4, 5]. This was the first international project to raise major awareness at a governmental level and influence the adoption of the 2003 Convention. The database of selected masterpieces of intangible heritage is available online and includes photographic and audiovisual documentation. Although it helped UNESCO raise awareness towards the need to safeguard intangible heritage, the project has subsequently been criticized for the exclusive connotation of the term 'masterpiece' [6] and its relatively limited educational scope.

Prior to the adoption of the 2003 Convention, UNESCO established several projects aimed at the safeguarding of intangible heritage. For example, the Red Book of Endangered Languages (subsequently known as Atlas of Endangered Languages) is a publication and online resource that provides basic information on more than two thousand languages¹. It has taken the form of an online map and archival resource and provides an encyclopaedic list of world languages ranging from vulnerable to extinct. However, the information available online is limited and there are limited learning possibilities available.

The Traditional Music of the World is a project that includes a compilation of recordings of traditional music from around the world [2] that have been made by ethnomusicologists in situ and then copied on vinyl and CD format. The project has made these recordings available to an international audience and has raised awareness about traditional music. However, it seems to act primarily as an archival resource and has limited educational application. Moreover, there is no online access to the recordings.

The Living Human Treasures project² was set up in the early 1990s in different national contexts, following existing programmes set up in Japan and Korea [7]. The project supports the transmission of traditional skills to young generations through a system of nationally sponsored apprenticeships. Apprentices learn the skills involved in traditional arts and crafts by living and working closely with master craftspeople (so called Living Human Treasures, i.e. LHT). The LHT are recognized by the government and receive a salary in support of their work. Although its impact varies, it could be argued that knowledge transmission is restricted to the chosen apprentices rather than a broader audience and, occasionally the transmitted knowledge is treated as something fixed and monolithic.

UNESCO has also played an active part in the establishment of national inventories of intangible heritage in several countries around the world.

¹ <http://www.unesco.org/culture/languages-atlas>

² <http://www.unesco.org/culture/ich/?pg=00061>

It becomes clear from the above that UNESCO has adopted a primarily archival approach to the safeguarding of intangible heritage. This can be related to the fact that the 2003 Convention recognizes registers and inventories as a first step of safeguarding intangible heritage. The projects above have been run by the international organization in partnership with national governments.

On the other hand, some other projects have been driven primarily by or for the benefit of local communities and rely on more participatory methods. These projects have not been initiated by national governments but rather by local museums, research institutes and local centres.

The Oral Traditions Project of the Vanuatu Cultural Centre is a relevant case in point (for more details on the project see [8, 9]). Vanuatu is a country in the Pacific comprised of more than one hundred islands. Held within the auspices of the national museum and cultural centre, the project is run through a network of volunteers, called fieldworkers, representatives of different communities who each year conduct research on traditional customs and cultural expressions. The fieldworkers have been trained in ethnographic research methods and photographic and audiovisual documentation. The project has been instrumental in raising awareness across the islands about the importance of traditional culture in the years following decolonization from the French and British Condominium government in 1980. Its primary function is to create a 'memory-bank' of traditional culture and languages, nevertheless the materials collected are not only kept for posterity but used in educational programmes for schools, museums and radio and community development. A key theme of the programme is the idea of 'heritage for development' translated into eco- and cultural tourism projects. The project has been going on since the early 1970s and some of the issues raised relate to the limited budget, the engagement of fieldworkers and how best to protect traditional culture from commercialization [10].

A further case relates to the topic of community-driven digital repatriation. This involves indigenous groups that collaborate with museums holding material sourced from their communities to create digital copies of objects or audiovisual recordings. For example, with financial and technological support from the National Museum of New Zealand Te Papa Tongarewa, a Maori tribe called Te Aitianga a Hauti prepared a digital resource to document their tangible and intangible heritage. This consists of a digital database containing photographic and audiovisual data related to collections in museums in New Zealand and overseas. The specific project was not only about cultural preservation but also community empowerment and education. Due to various limitations relating to intellectual property rights access to this resource is limited [11]. A similar project is the Sierra Leone Cultural Heritage project [12].

Online learning resources constitute another area of intangible heritage preservation. For instance, many indigenous groups in partnership with museums have created online heritage resources with a pedagogical focus. One example is the collaboration between the Lakota Native American tribe with the Smithsonian Museum of Natural History to create an online resource for the interpretation of the Lakota calendars, known as winter counts³. Through the project community members are empowered to share their stories and memories.

Moreover, MelOdyssea⁴ which was developed by the "Lilian Voudouris" Music Library of Greece is an online interactive tool for teaching the history of music in Greek from the medieval period until today. It is designed to preserve heritage by introducing and familiarising classical music to secondary school pupils, and those who love music and are in the early stages of their acquaintance with it. This is achieved through the study of major composers, works and forms that are considered to be milestones of Western European art music.

IS-HELLEANA, Intelligent System for HELLEnic Audiovisual National Aggregator⁵ is a Greek project in progress, which will provide effective access to audiovisual content that constitutes the spark for the further development and the appointment of Greek digital audiovisual content, not only in Greece but in the rest of Europe as well.

The EU has also supported projects relating directly and indirectly to the transmission of intangible heritage. For example, the I-maestro project⁶ aims to build a multimedia environment for technology enhanced music education. This employs self-learning environments, gestural

³ www.wintercounts.si.edu

⁴ <http://melodisia.mmb.org.gr/>

⁵ <http://www.helleana.gr/?q=el>

⁶ www.i-maestro.org

interfaces and augmented instruments promoting new methods for music training.

More directly related to intangible heritage and local development is the EU-funded project entitled Cultural Capital Counts⁷. The project aims to enable a positive development of six regions in Central Europe by focusing on intangible heritage resources like living traditions, knowledge and talent. This is done in order to increase the region's attractiveness for enterprises and the competitiveness of the regions. It takes forward strategies for local, sustainable development and collaborative research. But the focus seems to be more on the commercialization of intangible heritage than on how these practices and traditions can be transmitted to the next generations.

Another EU-funded project is Europeana⁸, which is the most well-known portal for exploring the digital resources of Europe's museums, libraries, archives and audio-visual collections, thus offering direct access to millions of books, manuscripts, paintings, films, museum objects and archival records that have been digitised throughout Europe⁹.

Additionally, the Mediterranean Voices Project¹⁰, which was funded by Euromed Heritage, aimed at creating a database of audiovisual information about cultural expressions and traditions from twelve cities in the Mediterranean. The project involved collaborative research and capacity building through a close partnership between universities and local communities. It addressed issues of memory, space and oral history and employed ethnographic research methods to investigate personal histories of the different cities. It is not clear how the database has been subsequently used, but the project has survived its 'funding life' and has taken a new form, exploring issues of heritage and identity beyond the Mediterranean.

What is interesting to note in the projects above is that they have been adopted at a grass-roots level and as such have a more direct and significant impact on heritage preservation among local communities. They are based on the active involvement of local communities and are aimed at serving local needs. As such they are not only focused on documenting and archiving intangible heritage, but more importantly in processes of transmission and dissemination among practitioners and the new generation.

As to the adoption of cutting-edge technologies for capturing and analyzing intangible cultural expressions (like sensors for motion capture, facial expression analysis, vocal tract sensing and modeling, etc.), to our knowledge, a few projects exist in the field mainly oriented to explore single aspects of expressions, but with no specific aim to capture, analyze and model the complexity of an artistic performance with educational purposes [13].

Thus the innovative strength of the i-Treasures project is that it aims to go beyond the current archival approach, by using advanced technologies to allow anyone to make an immersive and concrete experience of practicing the ICH. Furthermore, the project applies participatory methodologies in public engagement with local communities, in such way as to empower local actors to use new technologies in the transmission and dissemination of intangible heritage expressions for the benefit of sustainable community development.

3. THE CONTEXT

The i-Treasures project aims to propose new methods, employ and create innovative tools able to support and enhance the passing down of rare know how to new generations. To do so, the project makes 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

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⁸ <http://www.europeana.eu/>

⁹ There are a number of projects which provide digitised material to Europeana, such as CARARE (<http://www.carare.eu/>) – aggregates content for the archaeology and architectural heritage, ATHENA (<http://www.athenaeurope.org/>) – aggregates museum content and promotes standards for museum digitisation and metadata, Europeana 1914–1918 (<http://www.europeana1914-1918.eu/en>) – collects material relating to World War One, Europeana Libraries (<http://www.europeana-libraries.eu/>) – adds over 5 million digital objects to Europeana from 19 of Europe's leading research and university libraries, EUscreen (<http://www.euscreen.eu/>) – discovers and contributes television heritage material to Europeana, Musical Instrument Museums Online / MIMO (<http://www.mimo-international.com/>) – provides information on musical instruments held in public collections, etc.

¹⁰ www.medvoices.org

Treasures to apprentices”¹¹.

The i-Treasures platform is expected to take learners beyond a purely ‘informative’ experience, by offering not only the opportunity to acquire information on ICHs in different formats, but – more importantly - by allowing learners to be exposed to multi-modal and multi-sensory learning experiences and to receive appropriate feedback, so as to reach increased levels of competence in an easier, more direct, quicker and effective way [14].

In the wide panorama of the existing ICHs, the project examines four use cases in detail (areas of ICH), namely: 1) rare singing 2) dancing 3) craftsmanship and 4) contemporary music composition. Each use case has been further instantiated in different “sub-use cases”, namely:

1. rare singing, which includes: Cantu a Tenore, Canto in Paghjella, Byzantine music and Human BeatBox;
2. dancing, which includes: Tsamiko, Calus, Walloon and contemporary dances;
3. traditional handicraft, which includes the art of pottery;
4. contemporary music composition.

As will be demonstrated in the following, such a variety of the ICHs taken into consideration by the project represents one of the main challenges for the requirements definition process, given that the specificities of each cultural expression impose different requirements on the platform, especially in terms of how it will support the teaching and learning processes in the various domains.

In the following section, the paper describes how this challenge has been tackled by the project, namely how the specificities of the ten cultural expressions considered by i-Treasures have nurtured and forged the system and user requirements, by leading to the identification of the sensors to capture the main features of the ICHs and to the definition of the kind of support and feedback to be provided to users.

4. CAPTURING THE INTANGIBLE

The process of requirements definition started with the identification of the potential users of the i-Treasures platform and the broad definition of their needs. Apart from people from the general public, who might have broad ‘informative needs’ (i.e. finding materials of various formats on the platform), and researchers, who might have ‘enquiry needs’ (i.e. finding raw data and analysis on the platform to carry out further research), one of the main potential users of the i-Treasures platform is the learner. A learner may expect the system to provide not only informative materials, but – more importantly – the possibility of practicing one cultural expression and receiving support and feedback from the platform concerning the ‘quality’ of her/his performance. (‘cognitive and psychomotor learning needs’).

Thus, if we want the platform to support the acquisition of practical skills by the user, the system should be able to capture her/his movements through sensors, fuse and analyze the derived data (in such way as to pass from low level features to high-level features, which are meaningful for the human being) and then provide her/him feedback about her/his performance. In other words, the system should be able to compare these data with a model (i.e. the same performance by an expert) and give the user some kind of feedback about the ‘correctness’ of her/his performance: starting from ‘capturing’ the key aspects and features of the different ICHs, a process of data modelling is needed, which relies on advanced semantic multimedia analysis techniques. The new data acquired thus give life to a knowledge base containing a wealth of information, in such a way that it is possible to shape a variety of different teaching/learning paths, serving different scopes and specific educational needs, all aimed at contributing to the transmission of these peculiar artistic and cultural expressions [15].

From this perspective, the phase of data capturing is essential and the choice of what sensors to use and how to use them, is critical. Clearly, what data should be captured and how the data modelling should be carried out, as well as the kind of learning activities the system should propose to support effective educational interventions, strongly depend on the very nature of each cultural expression, so the analysis of each cultural expression (i.e. a process of knowledge domain definition) is a necessary condition to guide the platform design and development.

Such a process of knowledge domain definition and extraction of hidden aspects of the artistic

¹¹ <http://www.i-treasures.eu/>

phenomena, required the direct involvement of the persons who possess the knowledge and skills to perform these cultural expressions (herein called the “experts”). Several interactions with the experts were necessary to help defining ICH boundaries and characteristics. Such process represents *per se* one of the most important outcomes of the project, given that some of the ICHs considered in the project, are still unexplored.

In order to support the process, given that the project addresses ten different cultural expressions, it was necessary to conceive a common framework to allow the analysis of the various cultural expressions in a homogenous way, but being able at the same time to respect the peculiarities of each context. Besides, given that the local communities of the various cultural expressions are very different in nature (in terms of: size of the expert communities, average educational level, digital literacy skills, etc.), it was also necessary to allow a certain flexibility in the way the interactions between the Consortium and the experts were managed.

This led us to conceive a general framework for the description of any ICH form, which was then taken up and customized for the different cultural expressions, according to the specificities of each context and target population.

In the following, the paper describes first of all the common framework conceived by the Consortium, then the customization process, which was based on a collaborative process among the partners, and then we describe how the resulting questionnaires were delivered in the various situations.

4.1 A common framework for knowledge domain definition

As already mentioned, given that the project addresses ten different cultural expressions, it was necessary to allow their analysis in a homogenous way, at the same time respecting the peculiarities of each context. The framework was first conceived and proposed by ITD-CNR and then discussed among the partners [13]. It encompasses:

- General information of the cultural expression
- Physical dimension
- Emotional dimension
- Social dimension
- Knowledge and meta-knowledge dimension
- Context /environment dimension
- Teaching and learning dimension
- Value.

The *general information* about a specific artistic expression identifies the domain where the expression is rooted (dancing, singing, etc.) and gives an overview of its main characteristics, clarifying its historical and geographical origins, etc.

The *physical dimension* is aimed at describing how the performer should use the body, what specific parts of the body are involved, how, etc.

The *emotional dimension* is related to the performer’s feelings during the performance, her/his affective states.

The *social dimension* has to do with the relationships (if any) the performer has with the other people involved in the performance (other performers, audience, etc.).

The *knowledge dimension* includes both the theories and practice (notions, techniques, styles, etc.) the performer needs to master, those elements the performer needs to plan prior to the performance, and those s/he will need to keep under control and tune during the performance itself.

The *context/environment dimension* describes the place where the artistic expression is usually carried out, its main characteristics and the tools/costumes, etc. the performer needs to use.

The *teaching and learning dimension* investigates how the cultural expression is traditionally ‘taught’ or ‘transmitted’, if there is an official training path to be followed (with schools, teachers, etc.) or if learning occurs through informal methods (observation, apprenticeship, etc.).

Lastly, the *value* highlights the aspects of each cultural tradition that experts and local communities consider valuable and the reasons why they think it is important to safeguard and preserve that specific cultural expression.

Example questions for each dimension were proposed by ITD-CNR, in order to guide each

partner responsible for the various cultural expressions in the development of its own questionnaire to support the knowledge elicitation process (see Table 1):

Table 1. Example questions for each dimension

Dimension	Example questions for experts
General info	Provide a short description of the artistic expression (genre, basic features, etc.) What are the main distinctive traits characterizing the artistic expression? What are the origins of the artistic expression? Where is it geographically located? Can you describe the historical context where it originated? Can you give an idea of the level of diffusion of this artistic expression today (e.g. in terms of number of performers/groups, etc.)? ...
Physical	What parts of the body does the performer use (body, head, fingers, legs, internal organs, etc.)? What are the movements the performer will need to do? How will the performer enact these movements (rhythm, sequence, etc.)? ...
Emotional	Is there any mental or emotional attitude required by the performer during the performance? What are the performer's feelings while performing? How do feelings impact on /are they reflected in the performance? ...
Social	Does the performer usually perform alone or together with other people? What kind of relationship (if any) does the performer need to have with the other performers? What kind of relationship (if any) does the performer have with the audience? ...
Knowledge	What are the main notions the performer needs? What are the practical skills the performer needs? What are the techniques/styles the performer needs to master? What elements should the performer be able to keep under control /tune during the performance?
Context /environment	Where does the performer usually perform? Does the environment need to be specifically configured for the performance? Does the performer need any specific tools /instruments to carry out the performance? Does the performer use any specific personal equipment during the performance (clothes, etc.)? Where is the audience placed? ...
Teaching and learning	So far, how do people learn this ICH (by imitation, through dedicated training initiatives, etc.)? Where does this mainly happen (in informal settings, in formal educational settings, etc.)? What is the typical learning path to be followed by a learner (stages, duration, apprenticeship, etc.)? Are there people officially entitled to teach ('teachers') or is this delegated to practitioners (for example LHTs)? ...
Value	What is - according to you - the real 'value' of this artistic expression (historical value, economic value, innovation value, uniqueness value, cultural value, etc. ...)? What is the reason why you think this artistic expression is deemed to be safeguarded and preserved? What is - according to local communities - the real 'value' of this artistic expression?

As one can see, the dimensions cover all the main aspects encompassed in any intangible

cultural expression, independently of its nature: in the case of a dance, for example, as well as in the one of a singing style, there is always a performer moving her/his body (or parts of the body) (physical dimension). Similarly, there is always a context where the performance takes place with or without some kind of equipment (context/environment dimension); and there are always existing teaching and learning practices through which the cultural expression has been transmitted so far (teaching/learning dimension). There is always a corpus of knowledge upon which the performance is built (knowledge dimension), and a social dimension entailed (i.e. the performer always interacts with someone else, being it the audience, other performers, etc.).

The dimensions are wide and flexible enough to guarantee that any cultural expression is well represented, in all its various features. Clearly, the relevance of the dimensions may vary depending on the use case and/or artistic expression: for example, the ‘context/ environment’ can turn out to be scarcely relevant, or differently relevant, in the various cultural expressions.

In this way, it is always possible, starting from these ‘common’ dimensions, to derive specific dimensions for each ICH and to conceive ad-hoc questions to elicit the corresponding information from the experts of one specific knowledge domain.

4.2 Customization process and delivery

In order to support the i-Treasures partners in the process of taking up the framework and customizing it by producing specific questions (and thus questionnaires), ITD-CNR proposed a collaborative process that was carried out among the partners. Collaboration was fostered through the adoption of a “peer review” process, a very effective collaborative technique usually adopted to foster a social construction of knowledge. A sequence of steps were set up and agreed with the partners:

- Preparation of a first draft of the questionnaire: during this first step, the partners responsible for each ICH were asked to customize/adapt the example questions to their context/ cultural expression and circulate a preliminary proposal.
- Internal peer review for each use case: partners involved in the same use case were asked to read the lists of questions produced by others and provide feedback. During the revision phase, some of the experts were also contacted, who provided useful observations and comments on the questionnaire structure, on single question formulation, etc.
- Questionnaire refinement: during this phase, everyone had the chance to revise her/his own list of questions, according to the received suggestions/ inputs/ ideas.
- Final release: at this last stage, partners were asked to upload the final version of the questionnaire on the project website. Since the questionnaires were created in English, a translation in the language of the specific ICH was also expected (e.g. the questionnaire for the Sardinian Cantu a Tenore was translated into Italian, the questionnaire for Byzantine music was translated into Greek, the questionnaire for pottery was translated into Greek, Turkish and French, etc.).

The result of this collaboration and customization process was the construction of ten questionnaires (one for each cultural expression), which are all based on the common framework, but contain also specific questions and are able to capture the ‘intangible artistic forms’ of the project. The ten questionnaires were then delivered to the experts through different channels (i.e. online vs. face-to-face meetings), according to the local contexts and needs.

5. FROM ICH FEATURES TO DEFINITION OF REQUIREMENTS

After the data collection and analysis, it was possible to get a clear picture of each ICH and this was used as input for definition of requirements. In the following, the paper synthesizes how the main ICH features extracted through the dimensions drove in particular the choice of the sensors to be integrated into the platform, as well as the kind of support to be provided to foster teaching and learning processes.

Table 2 reports as an example an excerpt of the requirements defined for the Cantu a Tenore sub-use case. As the table shows the definition of requirements was nurtured directly by the dimensions. For example, the data collected from the experts related to the General information, the Value and the Context dimensions of the Cantu a Tenore guided the selection of the

materials/resources the system will provide access to. This happened for all the cultural expressions considered by the project, as the system will provide access to a number of resources (text, audio, images, etc.) for each of the ICH addressed.

Looking at the physical dimension is even more interesting given that this dimension always plays a key role in the definition of any cultural expression: in all the singing styles, as well as in the dances, the performer's body movements, or movements of specific parts of her body (head, finger, hands, legs, etc.) are the essence of a performance. This has a strong impact on the requirements of the system that is to be developed. Within the singing use case, the physical dimension of the Cantu a Tenore helped to identify the kind of sensors that will be adopted to capture the singer's movements (see Table 2): in this case the full body is less relevant (in Cantu a Tenore singers are almost standing statically), while sensors to track the acoustic signals are determinant, as well as those able to detect what happens inside the singer's body, especially at the level of the vocal cords and vocal tract. To this purpose, there are many sensors that could be employed, whose data should then be fused to gain a comprehensive view of the performance. For example, one could integrate the acoustic data coming from microphones, with data coming from ultra-sound sensors, a lip camera, a piezoelectric accelerometer, a breathing belt, etc. In the i-Treasures project a special hyper-helmet has been developed to bring a number of these sensors together¹². The hyper-helmet will thus provide data of different nature and coming from various sources /sensors (microphone + ultra-sound + lip camera) in such way as to guarantee an overall view of the main body parts engaged in the performance.

On the other hand, in the dancing use case the need is clearly to capture full body motion; to do so, one might use either marker-based technologies (such as for example optical motion capture systems), or markerless technologies (such as the Kinect). Of course, there are advantages and drawbacks of both the categories of sensors; in i-Treasures the former will be used in 'controlled conditions', to guarantee data accuracy, while the latter, which are less expensive, more lightweight and more portable, will be used in real settings. Besides, sensors need to be compatible with clothes (for example for dances which are performed wearing traditional clothes), and with instrument/tools (as in the case of handicraft, where the choice of sensors for hand and finger motion capturing needs to take into account the presence of the object manipulated by the potter), in such a way that sensors do not affect the performance.

The social dimension imposes constraints about how many persons to consider and consequently how many sensors to use and how. For example, in the case of polyphonic singing, such as the Cantu a Tenore, the four singers must sing together; during the recordings, though, one needs to record one singer at a time wearing the hyper-helmet. The solution identified by the project is a compromise, where the singer is recorded, while the other three are in another, nearby room, singing all together and with microphones in such a way that the single singer in the nearby room can listen to them. As another example, the complexity of the social dimension of some dances (for example the Walloon dances, which are group dances performed in couples) impose further requirements: in order to capture all the dancers together, we will need to use more sensors at a time, placed in various positions about the room.

The emotional dimension gives information about the emotional state of the performer. Thus EEG sensors can be adopted especially in those ICHs where tracking the emotional state plays a crucial role, as for example in the contemporary music composition use case. For the Cantu a Tenore this dimension has been judged not determinant, so no EEG will be used in this context.

The teaching/learning dimension gives indications about the kind of learning process to be proposed to learners through the system (what concepts, what activities, in what sequence, etc.); at a finer-grained level, this dimension also gives indications about the kind of feedback the system should be able to provide to the learner. In particular for the Cantu a Tenore, which traditionally is learnt by imitation, the system will be able to provide a 3D visualization of the singer's performance and to visually compare the user's performance with the expert's performance, in such a way that the user gets visual feedback and can watch the correct 'model' while trying to imitate it at the same time. To do so, the system will need to be able to fuse data coming from different sources (sensors) and make a semantic analysis (mapping low level features to high level

¹² Described in 'Deliverable 2.2: First Report on System Specification' of i-Treasures project (FP7-ICT-600676).

how to support technology-enhanced learning in ICH education

concepts); in i-Treasures algorithms will be developed able to analyze a content and detect and decide which concepts are ‘contained’ in the content. This will allow the provision of meaningful feedback to the learner.

Lastly, the knowledge dimension provided information about the concepts, theories, skills that must be mastered by the performer. For example, for the Cantu a Tenore it is essential that the learner becomes first of all an ‘aware’ listener of this kind of music, and then he/she can develop practical skills, so the system will be able to propose first of all listening activities during which the user learns how to recognize voices, styles, etc. typical of this Cantu, and then the system will propose practicing activities (with the user wearing the sensors and singing, while getting feedback).

Table 2. Excerpt from the list of Requirements defined for the Cantu a Tenore

Dimension	Requirements for Cantu a Tenore	M/D ¹³
general info/value	1.The system shall provide access to materials (in various formats) presenting the history, geographical coverage, basic characteristics of the Cantu a Tenore.	M
context	2.The system shall provide access to materials (in various formats) presenting the proper context of Cantu a Tenore, i.e. specific festival and costumes and other associated data.	M
physical	3.The system shall be able to capture the sound in a high quality in order to produce the related spectrogram and to identify fundamental frequencies, ornamentations, consonants, utter, and improvisations.	M
	4.The system shall be able to detect the singer’s vocal tract engagement (e.g. tongue, jaws, lips, anterior pharyngeal wall, vocal folds and vocal tract constriction).	M
	5.The system should be able to detect hand gestures/position and general postures.	D
	6.The system should be able to detect singers’ facial movements and gaze.	D
	7.The system should be able to detect singers’ abdominal breathing.	D
social	8.The system should be able to detect the reciprocal positions of singers.	D
	9.The system should be able to detect contacts between the singers.	D
teaching/learning	10.The system shall be able to display 3D visualization of the singer’s performance.	M
	11.The system shall be able to visually compare the user’s performance with the expert’s performance (for example if there is an error in the user’s vocal tract movement/position, the system shows the correct movement/position in parallel, so that he/she can watch and imitate at the same time).	M
	12.The system shall be able to recognize the four different voices using information related to the timbre, etc.	M
knowledge	13.The system shall be able to recognize different styles using information related to the timbre, etc.	M
	14.The system shall be able to provide learning paths starting from developing listening abilities and then going to production abilities.	M
	15.The student shall be able to practise by listening to songs and recognizing voices, styles, etc. (for example in the form of quizzes).	M
	

As one can see from the example above, all the information collected through the dimensions have informed the choices concerning the design of the system, which will make use of a variety of sensors and techniques to meet the specific requirements of the single cultural expressions.

¹³ M = mandatory requirement; D = desirable requirement.

6. DISCUSSION

In i-Treasures the process of identification of requirements was very challenging, because a preliminary, complex phase of knowledge domain definition was required in the various domains considered by the project. This was done with the direct involvement of more than 200 experts of the various cultural expressions, thus leading to demanding mechanisms of interaction and collaboration, whose complexity turned out to be an added value and thus can be considered one of the main project outputs in itself.

The involvement of the experts was not equally easy in the various contexts; sometimes barriers of different kinds (psychological barriers, low availability of the experts, etc.) required the project partners to be flexible and ready to satisfy the individual or community needs.

The interdisciplinarity and heterogeneity of the persons involved also imposed a certain flexibility to respect diversity, but at the same time the project needed a common framework to operate, which was given by the dimensions presented in the section above.

As has been illustrated, the dimensions allowed a good coverage of the various aspects/features entailed in the different ICHs, so that their specificities could easily be expressed, without assuming too distant perspectives. Despite the vagueness of some of the ICH addressed, the dimensions contributed to reveal and explore the phenomena.

Furthermore, the dimensions were understandable and 'easy' to explain even to non-literate people (as happened in the case of the Cantu a Tenore), by allowing an in-depth analysis of the phenomenon at the same time.

The variety of the cases considered in i-Treasures allows us to consider the dimensions potentially exportable to many other different cultural contexts and expressions.

The complete list of requirements defined for the system is contained in [13]. The list of requirements will certainly need to be refined and tuned after the first release of the system prototype, as in the project we foresee revising the requirements after testing the prototype with real users.

The requirements so far have been clustered per 'use-case', as we have seen that very often sub-use cases belonging to the same use case (for examples all the dances) share features that lead to the same set of requirements. Nonetheless, sometimes we also encountered specificities of one cultural expression which imposed specific requirements, so, even if working 'per cluster' allows us to make the platform potentially exportable to other, similar contexts, it is advisable not to disregard the single ICHs and their features.

As a final consideration, it is worthwhile stressing the fact that clearly there are no unique solutions able to accommodate the various requirements, nor consolidated methods or tools that can be adopted to support teaching/learning processes in these rare domains. This means that very likely many of the solutions proposed by the project will be exploratory in nature; besides very often they might take the form of a compromise, given that there is no rule of thumb in these contexts and the novel technologies adopted might not yet be fully consolidated. From this perspective, though, this is another important potential outcome of the project, which might provide important feedback and inputs to the technology development field.

7. CONCLUSIONS

This paper has presented the experience developed within the i-Treasures project with regard to the design and development of a platform able to support innovative technology-enhanced learning processes in the ICH field. Given that one ambition of the project is to go beyond mere ICH preservation, and allow an immersive and interactive experience by the user in practising intangible and rare artistic expressions, the platform will make use of novel sensors to capture the performance and allow the user to get immediate feedback on its quality. This is one of the most innovative aspects of the project; besides, the project does not address one cultural heritage only, but covers four different domains (use cases) and focuses on various exemplary forms for each of them, for a total of ten different sub-use cases. This implies the project is even more ambitious, as the platform will need to meet a number of requirements coming from the various domains.

Drawing on this experience, the contribution of this paper to this research area lies in the common framework developed to support the knowledge domain definition process, which is a conceptual, as well as an operative tool that can be exported and used in other contexts to extract

knowledge from the experts of any intangible cultural heritage. Furthermore, the paper has presented the process of definition of requirements, which again can be adopted in other contexts to develop similar platforms and novel technologies.

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