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D2.5

Final Report on User Requirements Identification and Analysis

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Main Authors:	Francesca Pozzi (ITD-CNR), Francesca Dagnino (ITD-CNR), Ioannis Poulios (UCL), Marilena Alivizatou (UCL)

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Author(s)	Francesca Pozzi (ITD-CNR), Francesca Dagnino (ITD-CNR), Ioannis Poulios (UCL), Marilena Alivizatou (UCL) Giannis Chantas (CERTH), Marius Cotescu (ACAPELA), Lise Crevier-buchman (CNRS) Stephane Dupont (UMONS), Nikos Grammalidis (CERTH), Evanthia Kalampoka (UOM), Paraskevi Kritopoulou (UOM) Athanasios Manitsaris (UOM) Sotiris Manitsaris (ARMINES), Leontios Hadjileontiadis (AUTH), Sohaib Laraba (UMONS), Maria Lazaridou (UOM), Pierre Roussel (UPMC), Dimitrios Theodorou (UOM) Filareti Tsalakanidou (CERTH), Christina Volioti (UOM)
Editor	Francesca Pozzi (ITD-CNR)
EC Project Officer	Marcel Watelet

Abstract	The deliverable contains the final recommendations and lessons learnt regarding the requirements of the i-Treasures platform.
Keywords	Intangible Cultural Heritage (ICH), preservation, education, technology, user requirements, recommendations.

Signatures

Written by	**Responsibility- Company**	**Date**
Francesca Pozzi	WP2 Leader (ITD-CNR)	13/04/2017
Verified by		
Francesca Pozzi	WP2 Leader (ITD-CNR)	30/04/2017
Approved by		
Nikos Grammalidis	Coordinator (CERTH)	26/5/2017
Kosmas Dimitropoulos	Quality Manager (CERTH)	26/5/2017

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1. Executive summary

The i-Treasures project deals with ICH (Intangible Cultural Heritage) preservation and transmission; its primary aim is to develop an open and extendable platform to provide access to ICH resources, enable knowledge exchange between researchers and contribute to the transmission of the rare know-how from Living Human Treasures to apprentices.

Overall, the main purpose of WP2 was to define the user requirements and system specifications of the i-Treasures platform. The process of requirements definition was iterative in nature as the project envisaged two stages for the platform development. In this deliverable we briefly recall the process followed at the beginning to define the preliminary list of requirements and how they were then revised during the second development cycle; then we describe how the requirements were again revised with the help of experts and we provide the final list of the requirements.

Even more importantly – in this document we reflect on the overall process and try to derive lessons and recommendations for future work.

In particular, drawn on the experience gained by our developers during the project, we provide a set of technical recommendations for future IT developments in similar initiatives. These include for example sensors or technological solutions that it is advisable to adopt, ways to implement things, design decisions to make, contextual conditions to satisfy, etc. that stand as an achievement or a limit in our experience.

Moreover, we derive a series of lessons learnt from the ICH experts involved in the project, especially as far as enablers and barriers that we have discovered in our attempt to safeguard ICH with Information and Communication Technologies (ICTs).

Among the recommendations and lessons learnt, here we would like to remind the broadest ones:

- Intangible heritage is constantly recreated and new technologies allow for new types of engagement with living human practices.
- Each heritage expression has different safeguarding needs, which require a different combination of technologies and other safeguarding actions.
- Safeguarding projects should be driven by the needs identified by heritage practitioners and professionals (also supported by ethnographers, anthropologists and heritage theorists), as they are in a better position to identify the most useful course of action. In this way, technologies will act as a supportive mechanism and not as the main driving force of a project.
- As far as ICH safeguarding, ICTs can play different roles and satisfy different kinds of needs, including: a) need for generic information about one ICH (for the general public), b) need for more specialized data and materials (for academics and experts), c) learning need for a learner who is only interested to the theoretical aspects related to one ICH, d) learning need for a learner who wants to learn how to *practice* one ICH.
- While a) and b) calls for a more archival approach, c) and d) are more innovative and challenging, and if on the one hand the project has provided several satisfying answers, there are still a number of limits in the technological solutions experimented during the project that need to be studied to be overcome.
- The global community of users of the platform is in any case a demonstration of the increased access to expressions of intangible heritage. Through i-Treasures, knowledge and cultural transmission have started being passed

on not only orally from generation to generation, but digitally through a computer screen. Although, we must be aware that such a resource cannot replace human interaction, it nevertheless offers a new opportunity for different modes of transmission and engagement with intangible heritage and opens the possibility to learn about them even to people who live very far from the place where these expressions originated.

2. Introduction

2.1 Brief introduction to the i-Treasures project

The i-Treasures project is an Integrated Project (IP) of the European Union's 7th Framework Programme under the theme “ICT for Access to Cultural Resources”.

The project is about ICH (Intangible Cultural Heritage): it looks at those rare and valuable living expressions and traditions that countless groups and communities worldwide inherited from their ancestors and still transmit to their descendants, in most cases orally or by imitation.

i-Treasures makes an extensive use of cutting edge ICT and sensor technologies with the ultimate 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*” (Project Description of Work[1]). Besides, the 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.

Starting from ‘capturing’ the key aspects and features of the different ICH, a process of data modelling is carried out within the project, by relying on advanced Semantic Multimedia Analysis techniques. The new data acquired on the ICH gives life to a knowledge base containing a wealth of information never available before; based on this wide new knowledge, it is then possible to shape a variety of different educational paths, serving different scopes and specific educational needs, all aimed at contributing to the transmission of these peculiar artistic and cultural expressions.

The i- Treasures educational platform is expected to take the learners beyond the concept of “learning by imitation”: besides offering the opportunity to acquire a variety of new information on the ICH in different formats (audio, video, narrative, etc...), allows learners to put themselves to the test, carrying out individual trials and receiving appropriate feedback and hints (in different formats, e.g. audio or video), so to reach increased levels of competence in an easier, more direct and quicker way.

Lastly, the platform also goes in the direction of safeguarding valuable patrimonies and sustaining the sense of identity of the local communities where the ICHs came to light, were practiced, cultivated and maintained, so to become integral part of their lives.

2.2 Focus on Work Package 2

Work Package 2 (WP2) is meant to analyse the various sub-use cases addressed in the project and to design the i-Treasures platform and its functionalities, thus laying the foundations for the work to be done in subsequent WPs.

In particular, objectives of this WP are:

- To analyse the **state-of-the art technology** in providing innovative and integrated solutions for access to cultural resources and for the safeguarding and transmission of intangible cultural heritage;
- To **analyse four ICH use cases** (rare traditional songs, rare dance interactions, traditional craftsmanship and contemporary music composition);

[1] http://www.i-treasures.eu/filedepot?fid=4

- To conduct a survey among experts and user organisations and to **identify User Requirements**;
- To identify Requirements and **define Specifications** for an open and extendable platform for access to cultural resources;
- To **update User Requirements** based on system demonstration evaluation and feedback from experts.

Directly related to the above mentioned objectives, under WP2 we have four main tasks:

- Task 2.1 - Analysis of the State of the Art and of the ICH Resources (M1-M4) [leader: UCL] <this task is closed>
- Task 2.2 - Analysis of Use Cases and Identification of User and System Requirements (M2-M27) [leader: CNR] < this task is closed >
- Task 2.3 - System Architecture Specification (M1-M27) [leader: UOM] < this task is closed >
- Task 2.4 - Feedback from Experts Requirements (M38-M50) [leader: UCL] <in progress>

While the first version of the requirements was presented in D2.1 [1] and then a refined version of the requirements was produced in D2.3 [2], in this document we discuss again the overall set of requirements, after having collected further feedback from our experts, with the final aim to derive final recommendations for future work.

The following table contains an overview of WP2 deliverables:

Table 2.1: WP2 deliverables: an overview

Deliverable	Month	Current status
D2.1 - First Report on User Requirements Identification and Analysis	6	✓
D2.2 First Report on System Specification	9	✓
D2.3 Second Report on User Requirements Identification and Analysis	27	✓
D2.4 Final Report on System Specification	27	✓
D2.5 Final Report on User Requirements Identification and Analysis	50	*This document*

2.3 Purpose and structure of this document

As already mentioned, this document is aimed at presenting the process of data collection happened in the final stage of the project and the results of such further revision of the requirements.

As a consequence, the present document is structured as it follows:

- Section 3 illustrates the way final feedback on the i-Treasures requirements was collected: the adopted method, as well as the data collection and analysis are described in detail, and then the main results of this phase are reported;

- Section 4 provides a set of technical recommendations for future IT developments in other projects/initiatives;
- Section 5 presents the final, revised list of the Requirements for the i-Treasures platform;
- Section 6 provides a synthesis of the main lessons learnt from the project, especially from the point of view of safeguarding ICH with ICTs;
- Lastly, Section 7 draws final conclusions on the work done.

3. Final feedback on the User requirements

Before reporting on the way final feedback have been collected and the main results obtained, in the following section we provide a synthesis of the previous work. Section 3.1 can be skipped by the reader, in case s/he has already got a clear idea of how the work was conducted within WP2.

3.1 Summary of previous work

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, it is possible to divide users of the i-Treasures platform into four different categories (see Table 3.1).

Table 3.1. i-Treasures Users' categories and needs

User	Need	Type of need
General public	…needs to find information of different kinds on the 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)**

As it is shown in Table 3.1, 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 labelled "informative".

A *scholar*, an expert or a teacher of one cultural expression 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 kind of needs are labelled 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 a 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 requirements started from the four types of needs identified above and then involved a number of stakeholders, to understand more in depths these needs and to decide with them which functionalities the system should be able to offer [3]. Thus in the project we took a *participatory approach* that was based on a close collaboration with and among all the stakeholders [4].

In order to collect data and information from the users, we organized workshops and used questionnaires and interviews, and adopted more ethnographic approaches based on the direct observation of the users' actions/needs [1] . Basing on this huge corpus of data, we defined the preliminary list of requirements, that was subdivided in five different functionality areas (Information, education & 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. 3.1).

In particular, the informative and enquiry/research needs are addressed by the functionality called Information, education & 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. 3.1 a synoptic map is provided, representing the relationships between system functionalities and users' needs.

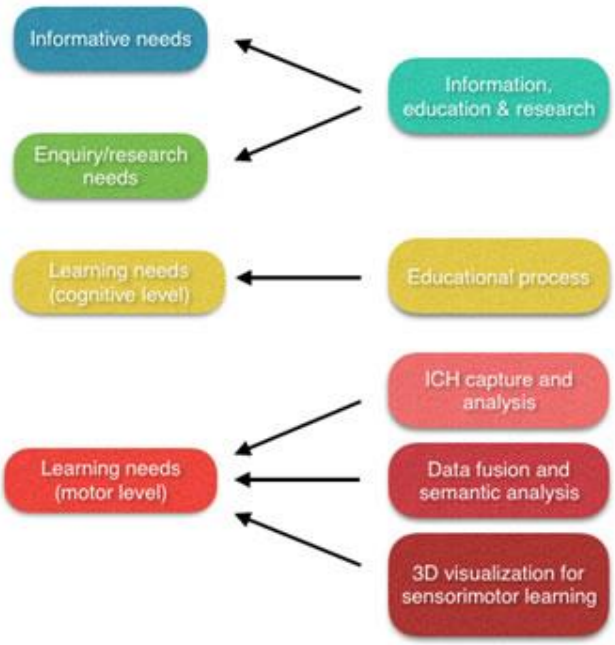

Figure 3.1 – From user needs (left) to system functionalities (right).

The requirements definition process was iterative and encompassed a later stage of requirements revision [2], based again on a direct contact with the experts, as well as on the evaluation of the first prototype of the platform [5] 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 result of this phase was the definition of a new list of revised and updated requirements [2]. which were then used to develop the final version of the platform [6] .

Now that the stages of development and evaluation are over, we are ready to come back once again to the requirements, this time with the aim to reflect on the work done, to derive final recommendations, especially in view of future work.

3.2 Collecting final feedback on the requirements

3.2.1 Method

In order to collect a final feedback on the i-Treasures requirements, we have come back to the main experts who helped us in the original requirements' definition and have asked again for their contribution.

In particular, during this phase we have organized a series of interviews, to collect experts' impressions about the actual fulfillment of the original requirements in the present version of the platform and also we have triggered them to elicit further requirements, if necessary.

Interviews were based on open questions (see Annex 1) which in turn were structured around the user needs and main platform functionalities.

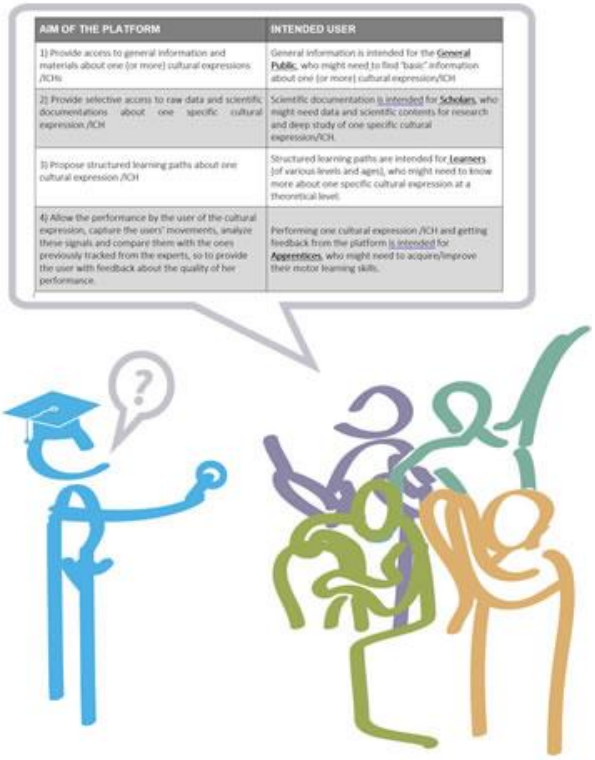

Figure 3.2 – Interviews to experts

Thus, data collection and analysis are qualitative in nature and this has been done also to differentiate the results of this work from those pursued by WP7, whose evaluation is mostly quantitative.

Furthermore, in order to draw more directly technical recommendations, we have also come back to the developers of the various platform modules and asked for their reflections concerning difficulties and challenges met during the development process. This allowed us to derive also a set of technical recommendations that should hopefully guide the work of future projects and initiatives in the same field.

3.2.2 Data collection and analysis

Data collection happened partially in the context of workshops organized by UCL within WP8 and partially as one-to-one interactions with some of the experts that were not present at the above mentioned workshops.

Table 3.2 contains the details regarding the experts and developers interviewed under this task.

Table 3.2. Synoptic view on the experts and developers interviewed

Interviews to experts (16)	• Canto a Tenore (1) • Paghjella (2) • Human Beatbox (HBB) (2) • Byzantine (1) • Tsamiko (1) • Pottery (1) • Contemporary Music Composition (CMC) (1) • Information Technology (IT) expert (3)

	• Generic CH expert (3) • Educational Technology (ET) expert (1)
Interviews to the i-Treasures developers (11)	• Facial Expressions and Modelling (1) • Body, Upper body and Hand/Finger Gesture Recognition (2) • Vocal tract sensing and modeling (1) • EEG Analysis (1) • Data fusion and semantic analysis (1) • Web Platform for Research and Education (1) • Sound processing (1) • 3D Visualization, sensorimotor learning (1) • Text-to-song (1) • Pedagogical planner (1)

3.2.3 Results

The corpus of the interviews was analysed by two independent coders with the help of the Nvivo[2] (software for qualitative data analysis). Interviews are, therefore, tagged and coded. In the following results of this process are reported, together with some abstracts of the interviews.

3.2.3.1 Providing information to general public

The first question proposed focused on the ability of the platform to provide information to the general public. The opinion of the experts about this ability is quite positive.10 out of 16 experts stated that the platform already fully reaches the goal of providing appropriate information for the general public. One expert, for example, has pointed out the following:

"It is certainly a base of information capable to help the general user and specially someone that has no previous experience, who is from a foreign country/ culture (to the one which is introduced) or for the future user." (Generic ICH expert)

Another expert has highlighted as particularly interesting the possibility offered by the platform to access information at different levels of details, i.e.:

"A nice feature of the platform, regarding access to this kind of information by a user of the general audience, is that this can be accomplished in a modular fashion so as the user can decide the level of detail of the information that is provided to him/her. In particular, at the first level, there is a general description of each (sub)use-case where the user can be generally informed about the expression/ICH, such as the place in which this is performed and its basic characteristics. At the second level, the user can search the repository for specific recordings belonging in this expression/ICH, in order to be informed in more detail." (Information Technology [IT] expert)

For a small group of experts (5) this ability of the platform is limited, due to the different degrees of detail among the different use cases (2), the quality of the info provided (2) and the form in which the info is provided (1):

"The platform could be in principle a good source of information for a general user, but the information available at the moment on the platform is not balanced: some sub-use cases are

[2] http://www.qsrinternational.com/

sufficiently covered, others are only generically presented." (Educational Technology [ET] expert)

"…The content is good but the form is unattractive to the general public ... Playing non-intuitive information ..." (HBB expert).

Moreover, a couple of experts have detected limits in the search engine operation and one in the results presentation.

"…*The information provided is so general and rather vague that I don't believe that anyone who needs to find basic information about a cultural expression would first visit that platform. I think it is rather intended to be visited by people who already know what they are looking for…*" (ICH expert).

Experts were also asked for suggestions, in order to improve contents and functionalities oriented to the general public. Answers touch upon different aspects and are mainly focused on contents. A couple of experts have proposed to increase the number of ICHs considered, another expert has suggested to enrich the resources made available, adding links to similar platforms or other, external and specific resources. As to the info already available, one expert has proposed to enrich contextual info (social, economic, etc.) for the considered ICH, two experts have pointed out to improve the format/modality in which info are proposed (less textual, more based on images and videos).

3.2.3.2 Providing scientific data and contents

The second question of the interview was oriented to understand whether, in the experts' view, the platform was able to provide scientific data and contents, to be used by researchers and academics for study and in-depth analysis of the use cases considered by the project.

Even in this case, the general impression is positive: 8 out of 16 experts consider the platform able to provide adequate data and contents for scholars. A couple of them have pointed out the following:

"…For a scholar, the platform provides a valuable tool not only to complement his/her knowledge about a particular cultural expression/ICH and obtain new pieces of information as a general user of the platform can do, but also to discover new knowledge that may not explicitly provided by the platform. This can be accomplished by the search repository utility and the functionality that presents the recordings and the characteristics that automatically detected in them in a very detailed manner."(IT expert).

"The platform includes an ICH repository and applications for scholars to browse and search its contents. This is a very useful resource although the content can be enhanced with further material." (Pottery expert).

Also in this case, 4 experts have detected some limits, related to the differences among the use cases (in terms of available contents and metadata):

"Using the advanced search some interesting data (recordings and feature analysis) can be retrieved for the different cultural expressions, among which the Canto a Tenore. What I noticed is that this not true for all the cases and the amount of materials available is different from a case to another." (Canto a Tenore expert).

One expert has highlighted the current limited capacity in this sense, but still considers it acceptable:

"At the moment, there are examples of raw data, but the repository is far from being a rich source of information, especially for some of the sub-use cases. This is not a big issue, if we consider the platform to be sort of feasibility study". (ET expert).

When experts were asked how they would improve this functionality of the platform, they basically suggested enriching the contents:

"A historian or a scientist of anthropology needs to know the cultural environment and the social circumstances which permitted the development and the continuity of the spiritual production. For this case, the platform has to cover other sections of the knowledge." (Other ICH expert).

"The automatic style recognition that the platform provides for some of the sub-use cases, shows a great potential for the examination of the different items being retrieved by the scholar in order to deduce the main characteristics that make them belonging in the same or different style, and even discover new relations between styles in terms of their basic characteristics. However, the main shortcoming of the aforementioned useful feature provided by the platform, is the not high number of items in the repository…Thus, it would be interesting in future to make a careful study of this feature with multiple items, as soon as they are available." (IT expert).

3.2.3.3 Offering learning paths to learners

The third question is focused on the ability of the platform to provide learners with learning paths through the LMS. This question stimulated accurate answers in the experts involved. This is probably due to the rich offer of courses made available, that experts accurately explored.

10 experts out of 16 have definitely given a positive opinion about the LMS courses; in the following some example of their statements:

"Learners could really find some specific details about the cultural expression they want to expertise. Of course it is commonly accepted that no digital platform can replace a living – human-teacher". *(Generic ICH expert).*

"*This (structured learning path) makes the learning experience efficient for the learner, since (s)he can follow independently of the teacher the learning path, while the teacher can monitor his/her progress and give directions, corrective comments and useful feedback being based on reliable data".(IT expert).*

"Yes, the steps taken are carefully designed so as to guide the user to get acquainted gradually with the learning procedure. Perhaps there is a need for more acoustic examples, so as to familiarize the user more". (CMC expert).

8 of them have combined their endorsements with suggestions for improvement, as for example the following;

"The platform offers more general information on HBB with introduction to the main rhythms and sound production than a course itself. The learning pathway would require more examples on breathing techniques, lip position and tongue articulation. Video examples and anatomo-physiological explanations would be necessary, as in the real learning process of these techniques: observation and imitation". (HBB expert).

Some experts have suggested improving the provided contents, in terms of types or amount of information:

"In relation to the above, an addition could be more information about the context (social, economic, oral interviews of people that had experienced the cultural expression at the time it was most in use, as well as other similar cultural expressions) that the cultural expression was at first used". (Generic ICH expert).

"Good architecture of the course in three parts, but it is necessary to review and to deepen certain information for each part; on the other hand, it is necessary to develop questionnaires with a set of questions more pertinent to test the good integration of the knowledge" (Paghjella expert).

Some experts have suggested improving the format in which contents are presented:

"A different style of presentation (e.g. with more images/videos) could me more appealing to younger audiences." (IT expert).

"Some kind of index could be added, so that the student can more easily navigate and find the content that he is looking for (e.g. how to center the clay)." (Pottery expert).

Other suggestions were related to improving interactive features, the analytics of the LMS platform and modules integration (not fully achieved with the 3D sensorimotor learning module)

3.2.3.4 Supporting user performance and providing feedback

The question was oriented to understand whether the platform, throughout the 3D module for sensorimotor learning, is able to allow the user to perform and collect significant feedback to improve the performance.

Given that for some of the cultural expressions considered the 3D game like application wasn't developed, some experts didn't express their opinions about this functionality.

The opinion of the experts was globally positive. 6 experts have declared the platform is perfectly able to support users in performing and getting feedback:

"The platform is able to allow performance by the user and also to provide effective feedback for the learner to improve his/her performance". (Tsamiko expert).

Other experts, although expressing a positive opinion, have also highlighted some limits of the current functionality, i.e:

"*The game applications are innovative and very useful. Especially the Generic Dance application[3] allows anyone to build new educational applications for dance or any other activity where the human body is used (e.g. gymnastics or martial arts), but the visualization and interaction aspects can be further improved". (IT expert).*

"The game application for learning pottery is innovative, but the interaction with the clay could be improved." (Pottery expert).

The experts have also given valuable suggestions regarding the feedback, by pointing out to work also in the direction of a formative feedback:

"It is very helpful for the user to take a final score of his presentation, but it would be better to have result for the exact time error of his/her performance." (Byzantine expert).

Another expert has suggested augmenting the interactive functionalities, i.e.:

"An idea is to show the areas (e.g. by a change of colour or flashing) where the (virtual) hand touches the clay, so that the user can have better control when shaping the object." (Pottery expert).

The possibility to customize the 3D application, and in particular to set the game according to specific needs, was also considered desirable, thus supporting the decision taken by the consortium to develop the Generic Dance Game application (that during the project was developed for the dances only and not for singing; see below for details):

"As a teacher, I'd prefer to have software that I could create my own new lessons in a 3D environment without having any extra help. That means that the teacher-user will be able to insert a specific recording, capturing data into the system (3d) to upload and to give all the information to my students (users). This works for the platform, but not for the 3D." (Byzantine expert).

IT experts remained focused on possible improvements based on technical advancement in data analysis:

[3] This an additional application developed by the consortium (not originally envisaged in the DoW): It allows to build a generic game for dances that allow a teacher to build a game for a particular dance, by adding new recordings, tagging them, etc. (see [6] for more details).

"In future, I would expect the automatic evaluation module of the environment to be able to assess the apprentice in a more abstract way, rather than comparing his/her performance with that of the particular expert. This means that the system should incorporate assessment and evaluation in stylistic terms and in a qualitative aspect, which is of course a challenging task. In case this is achieved, it would be constitute a great novelty for the particular research field and pedagogical methodology." (IT expert).

3.2.3.5 Global feedback and transferability of results

The last two questions are discussed together in the following, because they refer to the platform in general.

The former one was oriented to gather the global impression and feedback on the platform. The experts have globally confirmed their positive idea of the platform and some of them have also provided useful suggestions to improve it.

In particular, some experts (3) have suggested to enlarge the range of ICHs considered:

"*The platform could offer more choices for similar dances, so that the user can have a total view/opinion on this category of dances." (*Tsamiko expert).

Others have pointed out the level of interaction allowed by the platform and some functionalities could still be enhanced:

"The platform provides good examples of functionalities that could be further exploited in the future, especially as far as the sensori-motor learning functionalities are concerned. The Text-to-Song module is presently somehow not fully integrated into the overall design of the platform." (ET expert).

The latter question tackled the issue of the transferability of the outcomes of the project. The experts consider the outcomes of i-Treasures project quite transferable. In particular, a couple of them have suggested completely new areas where some i-Treasures outcomes could be exploited, i.e.:

"One great example would be learning specific types of martial arts. In this context, the practice of a specific martial art types can learn, when there is a lack of a martial art's expert available occasionally, the moves, forms, tactics of defence and offence of the particular martial art type. The transfer of the i-Treasures platform to this context is feasible because martial arts, as with dance, have a very well defined set of moves, forms and body stances needed in various situations. Thus, an apprentice can learn all these, so as to further proceed later in learning with the physical presence of a teacher or an opponent." (IT expert).

"Maybe, if I understand well the question, to domestic agricultural techniques or a variety of domestic ways of production (food products)." (ICH expert).

Another expert has envisaged the opportunity to extend the project outcomes to aesthetic education in general:

"I think there are potentials to transfer some of the results of the project not only to other ICH contexts, so to allow preservation and safeguarding of other rare intangible forms of art, but more in general, there is room for applicability also in the field of aesthetic education." (ET expert).

Nevertheless, a couple of experts identified possible limits of transferability:

"I think that the platform is particularly adapted to expressive forms based on a body activity that can be modelled, such as dancing (whole body), voice (singing, music), pottery (gesture of the hand), etc., but it could not adapt, it seems to me, to cultural heritages classified as PCI, including transmissivity, but vernacular knowledge that does not solicit the human body (ethnopharmacopoeia, tales ...)." (Paghjella expert).

4. Challenges and Technical Recommendations

As already mentioned, in this section we report the main challenges met during the development process by the i-Treasures developers and try to elicit technical recommendations for future work in similar projects/ initiatives.

4.1 Data Capture and Analysis

4.1.1 Facial Expressions Capturing and Analysis

For capturing Facial Expressions (FE) MS Kinect sensor was adopted. Registered colour (2D) and depth (3D) images of the face of a singer during his performance were sent from Kinect to the facial expression recognition (FER) module, that aims to achieve real-time, accurate, pose and illumination invariant recognition of basic facial muscle movements as well as basic emotions based on facial image streams [7] .

In the following the main challenges linked to the technology adopted and the development of the module are presented. Related recommendations are, then, listed.

Challenges

- Real time performance of the facial feature tracking algorithm using 3D and 2D image streams.
- Dealing with noisy 3D data. 3D data obtained by Kinect often present 'holes' or artefacts in the mouth area and on the nose sides. Also, the resolution of 3D data is not very high.
- Limitations of working area. In order for the Kinect sensor to provide good quality data, the singer/performer should be at a specific (close) distance from the sensor, thus limiting the volume where the performer moves. This could present a problem when the performer moves a lot, which, however, is not usually the case in singing.
- Tracking the mouth in human beat-box performances, due to extremely rapid lip movement.
- Tracking the mouth and nose when the singer wears the prototype hyper-helmet. Both facial areas are usually occluded by hyper-helmet components, such as the microphone, mini camera and ultrasound probe.

Recommendations for future work

- Fusion of tracking results obtained by 3D Kinect camera and 2D lip camera (used by the hyper-helmet) for better accuracy of mouth tracking.
- Use of two 3D cameras and fusion of tracking results for increased accuracy not only for facial tracking but also for 3D visualisation of the avatar's face in the game environment.
- Development of light-weight mobile application for singing based only on 2D image streams obtained by mobile phone cameras. This would enable the use of our tools/modules by a wider audience. It’s also a low-cost solution.

4.1.2 Body/Upper body and Hand/Finger Gesture Recognition

4.1.2.1 Body (dancing use case)

In the dancing use case several types of sensors were adopted (see [7]). Depth cameras (Kinect) were adopted to capture Tsamiko, Calus and Salsa Dance performers, while optical sensors were adopted for Walloon and Contemporary dances. Data from the sensors were sent to the appropriate modules of the platform. Furthermore, in the dance use case, a generic game application (called MotionMachine) was also developed, for the fast prototyping of feature extraction in mocap data for different setups [8].

In the following the specific challenges met in capturing the performers and in developing the different modules are discussed. Afterwards some recommendations are listed.

Challenges

Technical challenges

The Microsoft Kinect II sensor can achieve real-time 3D skeleton tracking, while at the same time it is relatively cheap and easy to setup and operate. However, the following limitations should be considered:

- It is designed to track the front side of the user and the front and back sides of the user cannot be distinguished.
- Tracking suffers from occlusions (e.g. self-occlusion by other body parts), non-distinguishing depths (limbs close to the body) or clutter (other objects in the scene, e.g. a chair).
- The movement area is quite limited (6 m^2).
- Some lighting conditions can make it difficult for Kinect II sensor to identify you or track your movements. Therefore, side or back lighting, especially from a window, should be minimized.
- The creation of a precise coordinate system calculator between Kinect II and the game platform Unity 3D.
- Data collected required the development of new tools for annotation.

Other challenges

- Availability of experts represented a considerable issue for tracking. In fact, for one specific use case (Walloon dance), very few people are considered as experts and have deep knowledge of the dance. Therefore a few gestures were recorded.
- Time for recordings was limited and we didn't have enough feedback to work and the analysis.
- Short time for state of the art studies.

Recommendations for future work

As for sensors, in the future, in order to reduce the limitations of the single Kinect sensor and extend the available active area, data from multiple Kinect sensors could be fused.

As for logistics, recordings need to be carefully planned and enough time is to be allocated to the data collection and data analysis phases.

4.1.2.2 Upper body and Hand/Finger Gesture Recognition - Pottery use case

The body and finger recognition module for the pottery use case takes input from both Kinect and Leap Motion sensors. The body skeleton data are captured by the Kinect sensor and the hand skeletal data by the Leap Motion sensor respectively. The capture process is performed synchronously from both sensors [8].

Challenges

- Intrusive technologies cannot be used in real conditions (i.e. the animazoo sensors can't be used in water)
- Non-intrusive technologies cannot be used (when the hand is in clay, the camera doesn't detect it).
- Fingers motion capturing is challenging with the available sensors in the market, as we cannot use them in clay or water.

4.1.2.3 Upper body and Hand/Finger Gesture Recognition - Contemporary music use case

In the contemporary music composition use case and in the virtual pottery use case, the general architecture of upper body and hand/finger gesture recognition that has been developed includes the sensors Kinect XBOX 360 camera and Leap motion controller. The difference is that in the contemporary music composition, we also use IGS Animazoo motion capture suit [8].

Challenges

- The conceptualization of a natural user interface that not only fuses data from different sensors and cameras, but also recognizes the performed gesture.
- The recognition of the gestural variations between the expert's and learner's performance by defining confidence bounds of the expert's gesture.
- The better the recognition is, the better and more fluid is the sonification.
- The whole development of the recognition methodology in a way that will make it easily usable from the users

Some challenges affecting in general Upper body and Hand/Finger Gesture Recognition:

- Reliability of the sensors remains an issue. We need to make sure that the quality of the data captured is good enough before proceed to analysis and use.
- In both cases it was really difficult to create the skeleton model.

Recommendations for future work

- Improvement of physical-based sound synthesis integration.
- Development of evaluation technique which will require user experience feedback.

4.1.3 Brain Electrical Activity Acquisition

The EEG Analysis module will comprise an EEG data acquisition and transmission device (the Emotiv EPOC device[4]) and a standalone application for data processing and classification (recognition), connectivity, and user interfacing (see [8]).

In the following the challenges met in data capturing, feature extraction and emotion recognition are listed. Some recommendations for the future are equally presented

Challenges

- EEG recording set-up by the user to be referenced
- EEG acquired signals quality to be secured across the whole interaction with IMI
- Maximization of emotion elicitation
- Efficient EEG-based feature extraction
- Efficient classification of four emotional classes (in the Valence/Arousal space)
- Real-time implementation of the EEG-based emotion recognition

Interconnection with other modules

Recommendations for future work

- Increase of the EEG data size, so to train deep neural networks in order to identify more hidden features that could reveal the changes in the emotional status
- Based on the above mentioned point, better optimization in real-time implementation
- Exploration of specific emotions (like those coming from Ekman[5]) instead of the Valence/Arousal space
- Use of the EEG analysis module to the compositional process of music, taking into account the topology of the activated brain and the EEG data characteristics, in combination with the identified emotions
- Introduction of various ways of mapping EEG-based recognized emotions to the artistic output (e.g., more features apart of tempo and dynamic, like texture, instrumentation, spatial organization, articulation, structural transformation).

4.1.4 Sound Processing

The main goal of this module is to perform the analysis of voice for the singing use cases. It also provides basic music analysis to support the dance use cases. The analysis module is a web service than can be called online using http calls, and the analysis results are saved in XML format (see [8]).

The development of this module presented several challenges discussed hereunder, followed by some recommendations.

Challenges

- Processing of sound beyond analysis, as in the case of HBB sound recognition, relies to a large extent on machine learning requiring annotated

[4] Emotiv Systems, Inc., San Francisco, CA (https://www.emotiv.com/)

[5] Ekman, P. (1999). Basic Emotions. In T. Dalgleish & M. Power (Eds.) *Handbook of Cognition and Emotion*. John Willey & Sons Ltd., ch. 3, pp. 45-60. https://www.paulekman.com/wp-content/uploads/2013/07/Basic-Emotions.pdf

databases from multiple experts, in order to build robustness to voice timbre variants. In this research, we have been able to show that instrument and sound detection for a single beatboxer is similar to real instrument recognition and detection. For the recognition system, larger databases may be required to make this system portable to various artists.

- Student would like in some cases to practice sounds or short musical phrases (sequences of sounds) without the constraints of a tempo or a sing-along mode. We addressed this using a various approaches that enable forced alignment. This makes real-time feedback not doable as alignment is a result of a global optimization over the sequence duration.

- Resources too scarce for investigating real-time and explicit feedback modes.

- Ideal teacher or expert feedback on a student performance not considered early enough in the process of database collection and annotation. And lack of defined ontology on type of feedback to be given for student error categories.

Recommendations for future work

- Investigate end-to-end deep learning training for HBB recognition, requiring data augmentation procedures to be developed for that particular content.

- Consider explicit feedback as a machine learning problem amenable to an active learning procedure.

- Collect larger data set of student practice (in addition to expert performances).

4.1.5 Vocal Tract Sensing and Modelling

Vocal Tract Sensing and Modelling module is intended to investigate the behaviour of different speech organs involved in speech production. This module uses input from several non-invasive sensors: an ultrasound (US) probe placed below the chin to image the interior of the buccal cavity and more specifically the contour of the tongue, a video camera to capture the image of the lips, obviously a microphone to record the audio, a piezoelectric accelerometer to extract the nasality, an electroglottography (EGG) sensor to measure the activity of the vocal chords from which the fundamental frequency can be easily extracted and a respiratory belt sensor (see [8]). A software module gives easy access to the raw signals as well as to the features extracted from these signals.

Challenges faced in the process of developing the module are listed in the following, as well as some recommendations dealing with the issues still to be addressed.

Challenges

- Design of a lightweight hyper-helmet supporting an ultra-sound probe, a video camera and a microphone.

- Synchronous acquisition of the signals from six different sensors.

- Design of several approaches to extract information from the US images and to associate them to a 3D model of the tongue.

- Design and implementation of an interface module to calibrate and acquire the different signals.

- Data display and analysis.

- Interface with the game.

Recommendations for future work

- Keeping the contact between the US probe and the chin for large movements of the jaw.
- Software and hardware compatibility between the sensor modules and the computing devices (Firewire, drivers, etc.).
- 3D model of the tongue to be animated from a 2D US image (tip of the tongue, asymmetry of the tongue).
- Use of a simpler, less realistic, more robust 3D model of the tongue.
- Make use of an extra camera to obtain a side view of the lips.

4.2 Data Fusion and Semantic Analysis

As said in [8] and described in [7] , the multimodal data fusion and semantic analysis module (MDFSA) is a subsystem of the i-Treasures central infrastructure, which has the role of the extraction of meaningful information from the multimedia content, i.e., the high level features. Acting adaptively to each sub-use case, MDFSA task takes as input the medium level features given by the WP3 module(s) and the knowledge representation model (Multi-Entity Bayesian Networks, MEBNs).

The development of the module presented the challenges presented hereunder, some recommendations were also provided for future works in the field.

Challenges

- Expert knowledge was essential for the design of the models used for semantic analysis
  - a training method was also crucial for capturing the implicit knowledge, i.e., this not provided by experts, which was codified with probabilistic mechanics. The Expectation Maximization (EM) algorithm was employed to this end.
- Combine data coming from multiple modalities (multimodal)
  - temporal alignment estimation was a challenge, which we overcame, and as a byproduct we developed a synchronization assessment method
  - need to learn the inter-modal relations of the data, which makes the expert knowledge even more necessary
- Big amount of data, our analysis algorithms needed a relatively considerable amount of time (~1minute)
- Models working solely with discrete data, thus discretization of the continuous time variables (i.e., timestamps) was needed

Recommendations for future work

- Speed-up the analysis algorithms, if possible make them to run in "real time"
  - use faster Application Program Interface (API's)
  - accelerate with parallel processing
- “Tough” problem: consider the style recognition to be extended to new (unknown till now) style discoveries
  - train MEBNs in an unsupervised manner
  - apply unsupervised learning also to discover medium-level features

4.3 Web Platform for Research and Education

The Web platform for Research and Education is the result of the integration of different component subsystems and modules developed within WP3, WP4, and WP5 into an operating open-source content management system. The design is based on user requirements and specification fully described in [7] The integration of Web Platform in details is covered in [6] and [9]

As stated hereunder, the process of developing the platform represented a challenge *per se*; other challenges and recommendations for the future will be presented in the following.

Challenges

- The entire process of designing and integrating so many diverse components into a single system.
- The integration of multiple components (Content Management System [CMS], Learning Management System [LMS], Pedagogical Planner [PP], 3D Module for Sensorimotor learning [3DVMSL], Digital Repository [DR], Text to Song [TTS]) developed in different programming languages and technologies.
- The whole development of the platform in a way that will make it easily accessible and user-friendly. (Single Sign On [SSO] mechanism to provide unique login, help guides included).
- The development of the platform in order to be extendable and capable to incorporate other types of ICH and new cultural services emphasizing on education.
- The platform includes many different units and a quite huge database. All components have to be skilfully integrated in order for it to operate fluidly.

Recommendations for future work

The i-Treasures platform can be enriched with more use-cases of rare know-how and courses to be an attractive ICH platform for a long time. Technology changes rapidly and the platform has to conform to new trends in order to maintain its innovative character by adapting new interactive tools.

4.3.1 The Pedagogical Planner

The Pedagogical Planner (PP) is a scalable cross-browser web-based application (see [10] and [11]). It supports the design, the construction and sharing of structured detailed pedagogical plans, guiding the teacher in the three learning design phases a) Conceptualization; b) Authoring; c) Implementation area. The application was integrated with the Learning Management System (LMS), to support the automatic (semi-)configuration of the LMS itself and allow an easy delivery of the educational activities and contents.

The process of adapting the tool to the specific needs of our population and the integration of the tool with the LMS represented substantial challenges that are briefly presented hereunder. Recommendations for the future are also discussed

Challenges

- Guiding the experts in defining the knowledge domain and the new specific fields to be included in the PP.
- Conceptually tuning the PP so it could best match the learning needs resulting in its application within the specific scope of the i-Treasures project (i.e. by adding specific fields never seen before in previous implementations of the tool).

- Improving the load capacity of the server hosting the module in order to accommodate an expected big number of concurrent users.

- Developing a secure SSO service between the i-Treasures website and the PP in order to offer a smooth and uninterrupted user experience between the main platform and the externally-hosted module.

- Developing a secure way for the module and the main platform to exchange data in order to allow the user to easily exports PP plans into the platform catalogue.

Recommendations for future work

- Adopt an interdisciplinary perspective in the development/adaptation of pedagogical tools.

- Use of a widely-known Learning Management System software supported by a vast community of developers (i.e. Moodle) for standardization and problem solving optimization.

- Increment the number of the Pedagogical Planner's core functionalities for quicker and better integration with the main platform.

4.3.2 3D Visualization Sensorimotor Learning

3D Visualization Sensorimotor Learning represents 2 game applications that use similar bases. One is for dance game application and is called "Generic Dance Game". This application allows related partners to generate any kind of dance game using specific data and evaluation algorithm.

The other application consists all other games including Rare Singing, Craftsmanship and CMC. The main focus of these games is to teach related topics step by step to the learners. In this application, the proposed activities always consist of a tutorial, an observation session and practice session (see [6]).

Both applications are developed in Unity 5 Game Engine, which is a popular game engine among the game industry. Many games use 3rd party devices and software like Kinect, Leap Motion and some server applications that are developed by other partners (see above for details).

Challenges

- Unity Engine issues that make it hard to generate the web build since Unity cancels the support for web player.

- WebGL will be used for the web build. However, WebGL build size is too much to launch on a browser.

- Unreported Unity Engine bugs that cause delays in development such as playing audio from the disk, memory leaks when playing videos etc.

- Since the project file is huge, managing the changes is difficult.

- There are 2 different projects. One for dance games, and the other for the rest. This situation causes problems when it comes to make similar or same changes on both projects.

- In dance applications, mapping skeleton data into dancer character is difficult. In many cases, data is not suitable and causes unexpected movements of the dancer.

- Game Applications are not supported on x86 computer structures.

- Game Applications use port connections to benefit other partners' applications. Some connections are too slow that sometimes causes game to crash.
- Analytics server sometimes refuses the connection.

Recommendations for future work

- All servers that are connected to game applications should receive and transmit the data faster.
- Servers should stay up 24/7.

4.3.3 Text to Song

The Text-to-Song software module was developed to allow users to synthesize new songs. This allows experts and students to experiment with different singing techniques, and preview new melodies or lyrics.

The speech synthesis technology is now mature enough to be adapted to singing synthesis applications, and most of the challenges that we encountered were related to data scarcity.

Challenges

- Many rare singing styles are part of cultures whose language is also rare, and linguistic knowledge is scarce. This was by far one of the most challenging part of developing the TTS module: not only we had to model and reproduce rare, and special singing styles, but we first needed to develop linguistic resources for the languages. This was a major deterrent to developing a text-to-song module for the Cantu in Paghjella.
- In the case of traditional singing styles, where there is no written tradition, building phonetic or musical corpora is extremely challenging.
- Producing high quality phonetic segmentation for under-resourced languages is a major challenge, and crucial for high quality synthesis. During the project we have developed novel bootstrapping techniques that helped us to minimize the need of expert manual segmentation.
- The flexibility of the singers to break down the performance into smaller pieces has a significant impact on corpus coverage, and thus the quality of the resulting system. The English and Byzantine systems – where we could record segments as short as words, are performing better than the "Canto a Tenore" system – where we could only record groups of three verses.

Recommendations for future work

- Involving performers and experts early into corpus design can dramatically affect the quality of the synthesis system.
- Recent improvements in Deep Neural Network driven ASR, trained with massive multilingual datasets could help to automatize data collection.
- Melody generation can be improved by learning different styles from many singers.

5. Final list of the i-Treasures User Requirements

In this section we report on the main changes we did on the i-Treasures requirements, drawing on the feedback got from experts and developers. The complete updated list of the Requirements is contained in Appendix 2.

As a general indication to read the tables in Appendix 2, we should say that the Requirements at this stage have been labelled as “M=Mandatory” or “D=Desirable”. A mandatory requirement is one that is really essential and the platform already supports it. A desirable requirement, instead, is something we would like to have, but was not possible to implement in the project, due to immature technology or lack of resources/time. Desirable requirements are those we would like to suggest for future work/investigations in future projects, Empty cells mean that specific requirement does not apply to that particular sub-use case.

The category of Requirements of the ICH Data Capture & Analysis module describe basically what parts of the body need to be captured for each sub-use case and provide indications about the sensors to be used. They also describe the preliminary analysis the system should be able to do. In respect to the previous list of Requirements (contained in [1] and [2]), at this stage we have basically added indications on sensors, basing on the experience gained during the project. For example, for the dance use case the project has highlighted that using one single Kinect can give problems in terms of occlusion and also covers a limited area (see Section 4.1.2.1), so now the Requirements suggest to adopt multiple Kinect sensors for this use case (see R.1.F).

At this stage, we have also been able to provide further indications about the way to do the analysis: for example, for the HBB a new requirement has been added (R.4.D), because the project has shown it is necessary to rely on larger databases, if one wants to allow detection and recognition of different singers (see Section 4.1.4). Similarly for the EEG, it is necessary to rely on big EEG data size, if one wants to train deep neural networks in order to identify hidden features that could reveal changes in the emotional status (see Section 4.1.3; R.3.B).

The Requirements of the Data Fusion & Semantic Analysis module describe the way the system should be able to fuse data from different sources, and what the system should be able to ‘detect/recognize’ in terms of styles, voices, patterns, etc. of the different ICH performances. In this case, no substantial changes have been done to the list of Requirements in respect to the previous version (see [2]), but one strong indication has been added (R.13) regarding the need to speed-up the analysis algorithms and make them running in "real time". This derives from the feedback got from the developers (see section 4.1.2).

The list of Requirements dealing with the Educational processes describe what the system should be able to offer to support structured teaching and learning paths in the field of the ICHs considered by the project. The Requirements provide indications about what is needed by the teacher to design and deliver effective educational interventions, as well as what the learner should be offered in terms of methods, activities and materials. In respect to the original list of Requirements, here we have added Requirements on the basis of the indications obtained by the experts and the users (see Section 3.2.3.3), who have pointed out to enrich the visual materials (R.21.C.) and have suggested to add specific materials/tools for some of the ICH (see R.25.A, R.26.A, R.27.A).

As far as the Requirements of the 3D Visualization Module for Sensorimotor Learning, they basically describe how the games should look like and what they should offer to support engaging learning in the fields of the different ICH. In the case of this category of Requirements, comparing the present list with the previous one

(D.2.3), we have empathized the importance of providing an effective formative feedback (R.38) as pointed out by experts (see section 3.2.3.4). Furthermore, a set of new Requirements has been added, to describe the user needs regarding the Generic Dance Game (R.43), building on the experience gained by the developers during the project (see Section 3.2.3.4).

The category of Requirements for the Web Platform for Research and Education basically describe what the system should offer in terms of information, data and materials to the generic user, as well as to the researcher for the different ICH. In this case, the list of Requirements has been enriched mainly following the indications of the experts (see Sections 3.2.3.1 and 3.2.3.2), that focused on: the enrichment of contextual materials for some of the ICH expressions (R.46.B was already present but its status has been changed from D to M to stress its importance), the necessity to provide more visual materials, rather than textual (R.46.F) and to provide links to already existing repositories and archives (also R.46.C already existed in the previous Requirement list, but its status has now been changed from D to M).

Last, very interesting addition to the Requirement list, suggested again by the experts (see Section 3.2.3.5) has to do with the possibility to further enrich the project platform with materials/data and materials concerning other ICH, so to enlarge the range of cultural expressions covered. This is particularly encouraging, as it indicates the project outcomes are considered useful and potentially interesting and transferrable even to other ICH.

6. Safeguarding ICH with ICTs: lessons learnt

In this section, we assume a higher point of view on the project and reflect on the main lessons learnt at a more general level, starting back from the main scope of i-Treasures, i.e. safeguarding and preserving ICHs with ICTs.

The i-Treasures project makes use of new technologies in heritage education and transmission by going beyond the digitisation of expressions of intangible heritage purely for archival purposes. The project has been developed in response to international developments in the discipline of heritage studies. More specifically:

6.1 Living heritage: continuity and change

The ultimate aim of the project was not simply the documentation but, in fact, the further/continual creation of heritage. In other words, heritage is seen and safeguarded in a continual process of evolution and creation, in the context of the community's connection with heritage.

This emphasis on the creation of heritage is in accordance with latest approaches in the discipline of heritage studies that tend to see people and buildings as crystallizations of persistent processes that continually carry on, undergoing continuous birth; heritage is continuously growing [12], see also [13]. The creation of heritage is also advocated by the UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage (henceforth cited as UNESCO Intangible Heritage Convention) and the living heritage approach. The Intangible Heritage Convention safeguards exclusively living — and not dead — intangible heritage, i.e. heritage that is "spontaneously transmitted from generation to generation, …liable to change at every manifestation and …characteristic for the groups and societies for whose sense of identity and continuity is of primary importance" *p.141* [14], see also [15]. Similarly, the living heritage approach focuses on "living heritage" (and not on all heritage types). The concept of "living heritage" embraces tangible and intangible heritage expressions, and is linked to the concepts of "continuity" and "change-evolution". Continuity is defined through a specific set of criteria with an emphasis on the function of heritage (see [16] and [17] *p.116)*. Continuity is seen as continually evolving over time to the present in response to the changing social, economic and political circumstances at a local, national and international level. In the context of continuity and change, the term "authenticity" is avoided or not emphasized (as in the UNESCO Intangible Heritage Convention, in differentiation from the UNESCO World Heritage Convention) since this term is considered to lead to the freezing of heritage at a point in time.

The project has aimed to create new knowledge concerning intangible heritage expressions by proposing novel methodologies and new technological paradigms for the processing and analysis of information related to cultural practices and expressions. In future, this could provide evidence concerning the evolution of a specific expression through its transmission from generation to generation or to other communities.

Yet, although the project addresses issues of heritage conservation, the involvement of ethnographers, anthropologists and heritage theorists in what should be safeguarded has been partial. In other terms, rather than conceptualizing "intangible heritage" as a broader context in which heritage expressions develop, the project has primarily focused on specific expressions or utterances of heritage (i.e. the sub-use cases analyzed by the project). This does not follow the approach suggested by the UNESCO Intangible Heritage Convention according to which the safeguarding of intangible heritage looks not only at the specific heritage elements but at "the scope of the heritage," which is not simply about specific rituals but about an entire belief

system (see [15], *p.132*), including the “promotion, enhancement, transmission… as well as the revitalization of the various aspects of such heritage” [18]

As a consequence, for future projects and initiatives, we recommend that – even if objects of study can be single heritage expressions – at the same time the wider context is also considered and taken into the due consideration, especially through a wider involvement of ethnographers, anthropologists and heritage theorists in general.

6.2 Heritage practitioners: an inseparable part of living heritage

The project has involved local heritage practitioners and also IT professionals with a more supportive, supplementary role. This emphasis on the heritage practitioners is in accordance with the changing “balance of power” in the discipline of heritage studies, with “the expert increasingly seen as the servant of the public, rather than its guide and educator” ([19], *p. 16*), and with the changing role heritage preservation itself is required to play in the society: it is less associated with heritage expressions and more with the interaction between people and their world and among people themselves (see [20]). In this context, a specific local community group is linked to the continual evolution and creation of heritage: it is the one that created heritage and sustains its original function, considers heritage an integral part of its contemporary life (in terms of its identity, pride, self-esteem, structure, and well-being), and sees the caring for heritage as its own inherent obligation (see [21] [21] [21] , [16], [17]). This community group is seen as an inseparable part of heritage, and is given priority over other communities operating on a local, national and international level. Conservation professionals and the other communities provide support to this specific community in the context of the continual evolution and creation of heritage. This emphasis on the local heritage practitioners, supported by the professionals, is also in accordance with the concept of “living human treasures” of the UNESCO Intangible Heritage Convention (http://www.unesco.org/culture/ich/en/living-human-treasures) and with the concept of “core community” of the living heritage approach.

The project has enhanced the connections between the heritage practitioners and the making of heritage through the establishment of an active group of “experts”. As such, heritage practitioners have been captured using multimodal sensors and image/signal processing, and pattern recognition techniques have been applied to extract low and medium level features. Nevertheless, although these technologies allow for the digitization of detailed information related to the performance of intangible heritage, in some cases they do not seem to have been developed in response to preexisting needs of local communities or practitioners. Rather they have been an opportunity for research and technological experimentation.

For future projects and initiatives, we recommend involving heritage practitioners not only in the decision process of what needs to be tracked but also in the design of how to track it.

6.3 The users of the platform: experiencing and further creating living heritage

The formation of a digital platform that addresses not only the local community, but mostly the virtual global community, is in accordance with the increasing recognition of the “emerging modes and technologies for accessing and experiencing heritage” and of the virtual global communities as a stakeholder group respectively in the heritage field, as characteristically noted in the most influential Nara+20 Document [22].

Furthermore, the digital platform contributes to the enhancement of the experience of heritage by the users. This follows recent approaches that tend to see and offer heritage as a visitor experience (see [23], [24]). Yet, the current version of the digital platform does not fully apply the potential of the "experience model" methodology tools, such as staging the experience as a theatrical play and designing the experience as a journey (on the application of the "experience model" methodology to the business sector see [25] and [26] and to the cultural sector see [24]). A future development of the platform could take the above models into consideration.

Another strength of the project is its potential to raise awareness about the safeguarding of heritage among younger generations who are particularly familiar with these types of technologies. A series of demonstration activities at schools and youth clubs have shown that young people show an increased ability at engaging with the digital games developed within the project. Moreover, education professionals were particularly interested in adopting the LMS system and the Pedagogical Planner methodology as part of a technology integrated curriculum. The ability of the platform to combine different resources (such as documents, images, audio tracks, and videos) in a form of a digital library was characterised as a useful tool by both educators and learners.

On the contrary, as one may expect, people who are less familiar with digital tools and applications, have shown difficulties in the interaction with the platform. Moreover, anthropologists and social researchers have suggested that the nature of the games and more in general remote learning systems might increase the risk of a limited knowledge and understanding of the heritage expressions. This should be taken into account also in future projects and initiatives, in such a way that the risk of the technology bias is kept as low as possible.

6.4 The broader community: achieving sustainable development through living heritage

Through the emphasis on the local heritage practitioners in the context of the project (see above), conservation practice as well as sustainable development focuses on the local level.

It is important to further note that the experience and further creation of heritage by the virtual global community is based upon the creation of heritage by the local heritage practitioners, with the emphasis placed upon the local practitioners. This means that, in the context of the project, despite the increasing role of the global virtual communities, sustainable development is seen as rooted primarily in the local level.

The active engagement of local heritage practitioners and local heritage professionals by the project is manifested, besides the demonstration activities discussed in WP6, and in a series of other public engagement activities, such as the training workshops and pilot courses for postgraduate students, organized as part of i-Treasures.

Yet, despite the coordinated efforts to embed i-Treasures technologies within the local communities of heritage practitioners, heritage professionals and educators, it is not always easy to find ways for use beyond the life-span of the project: the aim of the public engagement and demonstration activities has been to make the platform more accessible to the public, but also relevant communities of practitioners and professionals.

7. Conclusions

The project has been set up in response to international developments in heritage studies, regarding: living heritage, heritage practitioners, users of the platform, and the broader community.

The main lessons learnt that may have relevance to other projects of safeguarding heritage through new technologies:

Living heritage

- Intangible heritage is constantly recreated and new technologies allow for new types of engagement with living human practices.
- Each heritage expression has different safeguarding needs, which require a different combination of technologies and other safeguarding measures.
- Safeguarding projects should be driven by the needs identified by heritage practitioners and professionals, as they are in a better position to identify the most useful course of action. In this way, technologies will act as a supportive mechanism and not as the main driving force of a project.
- Ethnographic perspectives should be embraced in the development of technologies. This can enable a holistic approach towards the conceptualisation and selection of the use cases and their safeguarding needs.

Heritage professionals

- Ethnographers, anthropologists and heritage theorists should be heavily involved in what should be documented, safeguarded and researched. Methodological input should also be sought from these professionals.

Heritage practitioners

- Technologies need to be developed in direct response to the needs of the heritage practitioners and the local communities. Thus, it is important to ensure that relevant individuals provide input for the conceptualisation of the safeguarding needs of specific use cases.

Users

- The virtual global community of the platform is a demonstration of the increased access to expressions of intangible heritage. Through i-Treasures, knowledge and cultural transmission are passed on not orally from generation to generation, but digitally through a computer screen. Although, such a resource cannot replace human interaction, it nevertheless offers an opportunity for different modes of transmission and engagement with intangible heritage. Moreover, it raises awareness about the value and importance of such cultural expressions beyond the communities directly concerned. However, the primary users and beneficiaries of such projects should be the bearer communities.

Broader community

- Despite the dissemination and training activities, it is important that sustainable development is addressed in a more long-term dimension, with a stronger emphasis on the development of lasting collaborations with local communities and administrations.

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Annex 1 – Template for the expert Interview

EXPERT INTERVIEW

(WP2 - feedbacks from the experts on the i-Treasures platform requirements)

Dear expert,
we kindly ask you to help us getting feedback about the work we have carried out within the i-Treasures project. To this aim, in the present interview, we propose a number of questions, aimed to collect your reflections/impressions/opinions about the i-Treasures platform.
Overall, the interview should take about 20 mins, but of course the duration also depends on the time you would like to spend on your responses. Please feel free to express your ideas, as this will help us to improve our work.
Thanks a lot for your collaboration!

Name and Surname: _____ Gender: _____

Profession/ Position: _____ Age: _____

Educational qualification: _____

Cultural expression /ICH (Intangible Cultural Heritage) you are expert of / you are interested

in:_____

In order to contribute to the interview, you need some preliminary information about the project.
So, before proceeding with the questions, please read carefully the following.

Main objective of the i-Treasures project is to propose innovative methods and tools to support safeguarding and preservation of a number of cultural expressions /Intangible Cultural Heritages (ICHs).
To achieve this objective, the project has designed and developed a platform, able to:

AIM OF THE PLATFORM	INTENDED USER
1) Provide access to general information and materials about one (or more) cultural expressions /ICHs	General information is intended for the General Public, who might need to find 'basic' information about one (or more) cultural expression/ICH
2) Provide selective access to raw data and scientific documentations about one specific cultural expression /ICH	Scientific documentation is intended for Scholars, who might need data and scientific contents for research and deep study of one specific cultural expression/ICH.
3) Propose structured learning paths about one cultural expression /ICH	Structured learning paths are intended for Learners (of various levels and ages), who might need to know more about one specific cultural expression at a theoretical level.
4) Allow the performance by the user of the cultural expression, capture the users' movements, analyze these signals and compare them with the ones previously tracked from the experts, so to provide the user with feedback about the quality of her performance.	Performing one cultural expression /ICH and getting feedback from the platform is intended for Apprentices, who might need to acquire/improve their motor learning skills.

Disclaimer
…… date, / <signature>

Please consider the first aim of the platform (i.e. its ability to provide information to general public) and express your opinion about it. Feel free to express your impressions and motivate them.
In your opinion, is the platform able to effectively provide information for a general user who wants to find basic contents about one cultural expression /ICH? Is what the platform offers in line with your expectations? Would you provide anything different? Have you got any suggestion for changes or additions? …

Please consider the second aim of the platform (i.e. its ability to provide scientific data and contents to scholars) and express your opinion about it. Feel free to express your impressions and motivate them.
In your opinion, is the platform able to effectively provide scientific documentation for a scholar who wants to deeply study one cultural expression /ICH? Is what the platform offers in line with your expectations? Would you provide anything different? Have you got any suggestion for changes or additions? …

Please consider the third aim of the platform (i.e. its ability to offer learning paths to learners) and express your opinion about it. Feel free to express your impressions and motivate them.
In your opinion, is the platform able to offer adequate learning paths for learners who wants to know more about one cultural expression /ICH? Is what the platform offers in line with your expectations? Would you provide anything different? Have you got any suggestion for changes or additions? …

Please consider the fourth aim of the platform (i.e. its ability to allow performance by the user and provide feedback) and express your opinion about it. Feel free to express your impressions and motivate them.
In your opinion, is the platform able to effectively allow performance by the user who wants to learn how to perform one cultural expression /ICH? Is the platform able to provide effective feedback for the learner to improve her/hi performance? Is what the platform offers in line with your expectations? Would you provide anything different? Have you got any suggestion for changes or additions? …

Please reflect on the i-Treasures platform as you have experienced it and give any other idea /feedback about it. Feel free to express your impressions and motivate them.
In your view, are the platform aims adequately covered? Would you have expected any other aim to be covered by the platform?

Please reflect on the cultural expressions /ICHs addressed by i-Treasures and give your impression regarding transferability. Feel free to express your impressions and motivate them.
Do you think that any of the outcomes of the project could be applied also to other contexts? Could any of the platform functionality that you have experienced be transferred to other cultural expressions/ ICHs?

Annex 2 – Final list of i-Treasures Requirements

SUB USE CASES			
S1	Canto a Tenore	D1	Tsamiko dance
S2	Cantu in Paghjella	D2	Calus dance
S3	Byzanthine music	D3	Walloon dance
S4	Human Beat Box	D4	Contemporary dance
M1	Cont. music compos.	P1	Craftmanship

REQUIREMENT PRIORITY	
M	Mandatory
D	Desirable

ICH Capture & Analysis

General category	Requirement	S1	S2	S3	S4	D1	D2	D3	D4	M1	P1
R.1 The system shall detect and capture movements	R.1.A - The system shall be able to capture the singer's vocal tract engagement (including tongue, lips, vocal folds and nasal vibrations).	M	M	M	M						
	R.1.B - The system should be able to capture singers' abdominal breathing with suitable sensors.	D	D	D	D						
	R.1.C - The system shall be able to detect the movements of the lower body, especially feet.					M	M	M			
	R.1.D - The system shall be able to detect the movements of the upper body, especially hands (palm) and fingers.									M	M
	R.1.E - The system shall be able to detect the movements of all the body parts.								M		
	R.1.F - The system should be equiped with multiple kinect sensors to prevent occlusions and extend the 'active area'					M	M	M	M		
	R.1.G - The system shall be able to detect singers' facial movements.	D	D	D	M						
R.2 The system shall capture and elaborate sounds	R.2.A - The system shall be able to capture the sound in a high quality in order to extract pitch.	M	M	M							
	R.2.B - The system shall be able to capture 4 singers together and be able to separate their single voices.	D	D	D							
R.3 The system shall detect the performer's emotions	R.3.A - The system shall be able to detect the emotions of the performer through EEG.									M	
	R.3.B - The system should rely on big EEG data size, so to train deep neural networks in order to identify hidden features that could reveal the changes in the emotional status									D	
R.4 The system shall recognize and analyze parts of performances	R.4.A - The system shall be able to analyze the basic postures and motion patterns of the dance.					M	M	M	M		
	R.4.B - The system shall be able to analyze the basic elements of a song/chant	M	M	M							
	R.4.C - The system shall be able to extract and recognize imitated instruments by the singer.				M						
	R.4.D - The system should rely on large databases to allow detection and recognition of different singers.	D	D	D	D						
	R.4.E - The system shall be able to analyze the basic stages of the wheel-throwing procedure as well as hand and motion patterns.										M
R.5 Sensors set-up shall adapt to a performing area ranging from 2x2 to 6x6 m	R.5.A - The sensors set-up should allow the dancer to move in a minimum area of 2x2 m.					D					
	R.5.B - The sensors set-up should allow the dancer to practice in a minimum area of 6x4 m.						D				
	R.5.C - The sensors set-up should allow the dancer to move in a minimum area of 4x4m.							D			
	R.5.D - The sensors set-up should allow the dancer to move in a minimum area of 5x5 m.								D		
	R.5.E - The minimum distance between a camera and a dancer shall be at least 2 m.					M	M	M	M		
R.6 Sensors should not affect or hinder performance and viceversa	R.6.A - Sensors should not affect the performance of the users. Sensors technology should cause no or minimal disturbance to the performers.	D	D	D	D	D	D	D	D	D	D
	R.6.B - Sensors should not be affected by the electromagnetic field produced by the electric wheel.										D
	R.6.C - Unobtrusive sensors should be used for capturing the potter's finger, hand and body gestures.										D

Data Fusion and Semantic Analysis

General category	Requirement	S1	S2	S3	S4	D1	D2	D3	D4	M1	P1
R.7 The system shall rely on consistent measurements	R.7.A - All measurements shall be time-stamped, so that only consistent measurements (those falling within a specific time-window) are fused in each data fusion cycle.	M	M	M	M	M	M	M	M	M	M
	R.7.B - Medium level features should have corresponding timestamps to be used for semantic analysis and multimodal data fusion.	M	M	M	M	M	M	M	M	M	M
R.8 The system shall fuse data captured from /in different modalities and from different sources	R.8.A - The system shall be able to fuse data from different modalities.	M	M	M	M	M	M	M	M	M	
	R.8.B - The system shall be able to fuse data from different sensors in order to more accurately analyze upper body motion.									M	M
	R.8.C - The system shall be able to fuse data from music and body motion.					M	M	M	M		
R.9 The system shall recognize different styles (among different performances)	R.9.A - The system shall be able to recongize different styles using information related to the hand gestures.										M
	R.9.B - The system shall be able to recongize different styles, i.e., instrument specialization of Human Beatbox, using information related to intrument characteristics (e.g., timbre for musical and beat onset for percussion instruments).				M						
	R.9.C - The system shall be able to recongize different styles of chanting/singing, using information related to timbre, pitch, rythm, ornamentations, etc.	M	M	M							
	R.9.D - The system shall be able to recongize different styles, using information related to the number of steps, the identification of specific motion patterns and the type of music.					M	M	M			
R.10 The system should detect synchronization aspects	R.10.A - The system should be able to recognize the synchronization between dance figures and music rhythm.					D	D	D	D		
	R.10.B - The system should be able to analyze at the same time the basic postures of two people dancing together.							D			
	R.10.C - The system should assess the synchronization of a dancer with respect to rhythm.					D	D	D	D		
R.11 The system should recognize different singers' voices / instruments in a performance	R.11.A - The system should recognize different voices take them into account in the data fusion process.	D	D	D							
	R.11.B - The syetm should recognize different instruments to which the beatboxer is specialized an HBB performance.				M						
R.12 The system should allow measures enabling the stylistic characterization of improvised sequences	R.12.A - Measures enabling the stylistic characterization of improvised dance sequences should be developed.								D		
R.13 The system should be able to analyse data in real time	R.13.A - The system should be able to analyse data in real time (through speeding up the alghorithms for analysis).	D	D	D	D	D	D	D	D	D	D

Educational Processes

General category	Requirement	S1	S2	S3	S4	D1	D2	D3	D4	M1	P1
R.14 The system shall support teachers/experts in the design and planning of innovative educational interventions in the ICH field	*R.14.A* - The system shall allow the conceptualization of an innovative education intervention, by supporting learning objectives definition, target population analysis, context description, etc.	M	M	M	M	M	M	M		M	M
	R.14.B - The system shall support contents mapping, so to help teachers/experts in the definition of the contents to be covered during the educational intervention.	M	M	M	M	M	M	M		M	M
	R.14.C - The system shall support the representation of sequences of activities, in such a way that the teacher/expert can describe the various steps of the educational intervention.	M	M	M	M	M	M	M		M	M
	R.14.D - The system shall be able to represent ordered and unordered sequences of activities, in such a way that the teacher/expert can design interventions for both formal and informal contexts.	M	M	M	M	M	M	M		M	M
	R.14.E - The system shall be able to represent both mandatory and optional activities, in such a way that the teacher/expert can design flexible and personalizable learning sequences.	M	M	M	M	M	M	M		M	M
	R.14.F - The system shall support the detailed description of each single activity, including specific objectives, settings, tools and resources to be used, instructions for students, etc.	M	M	M	M	M	M	M		M	M
R.15 The system shall be endowed with a Learning Management System (LMS), able to host the courses for the students	*R.15.A* - The system shall allow the (semi-)automatic exportation of the design produced by the teachers/experts, into a course in the Learning Management System, ready for the students.	M	M	M	M	M	M	M		M	M
	R.15.B - The system shall be able to provide an easy and intuitive access to the courses /materials on the Learning Management System.	M	M	M	M	M	M	M		M	M
	R.15.C - The system shall be able to provide guidance to the user regarding how to use the LMS.	M	M	M	M	M	M	M		M	M
	R.15.D - The system shall allow to display all the descriptive information about the courses (objectives, contents, sequence of activities, etc.).	M	M	M	M	M	M	M		M	M
	R.15.E - The system shall allow to display all the descriptive information about each single activity, including the instructions for students.	M	M	M	M	M	M	M		M	M
R.16 The system shall allow learning to be achieved following a variety of methods/ from a variety of sources	*R.16.A* - The system shall be able to deliver different types of learning activities (i.e.: individual study; exercises; assessment exercises; sensorimotor learning activities, blended-learnign activities).	M	M	M	M	M	M	M		M	M
	R.16.B - The proposed learning path shall promote learning by imitation	M	M	M	M	M	M	M		M	M
	R.16.C - The student shall be able to make practice by listening to songs/chants and recognizing voices, styles, rhythms and vocal gestures (for example in the form of quizzes).	M	M	M	M						
	R.16.D - The overall learning path shall start from developing listening abilities and then shall go to production abilities.	M	M								
	R.16.E - The system should provide videos of people performing the dance as well as video of a teacher explaining the dance.					D	D	D			
R.17 The system shall adjust lessons/difficulty levels according to students' characteristics and abilities	*R.17.A* - The system shall be able to adjust the difficulty level of the quizzes according to user's responses.	D	D	D	D	D	D	D		D	D
	R.17.B - The lessons should depend on the age or experience of the student.	D	D	D	D	D	D	D		D	D
R.18 The system should allow to suggest the average number of lessons /repetitions for each block/unit of knowledge and for the whole performance	*R.18.A* - The learning process should foresee that the average number of lessons is adapted to the difficulty of the dance figure being taught.					D	D	D			
	R.18.B - The user should be able to define the number of repetitions for each dance figure.					D	D	D			
R.19 The system should allow to set/suggest the average time for a single lesson and for the whole endeavor	*R.19.A* - The proposed learning path should take into account that the average time of a typical dance lesson should be around 45-60min.					D	D	D			
	R.19.B - The proposed learning path should take into account that the average time of a pottery typical lesson should vary from around 1 - 2 hours up to 3-4 hours (e.g. Turkish pottery).										D

	R.19.C - The proposed learning path should envisage that the average number of hours overall required to learn pottery is 200 - 400.										D
R.20 The system shall support a progressive learning approach, in which performance is divided in smaller parts/entities that are taught independently.	*R.20.A* - The learning path shall support a progressive approach, in which dance is divided in smaller parts/entities that are taught independently.					M	M	M			
	R.20.B - The learning path shall support a progressive approach, in which the pottery course is divided in smaller sections in which objects with increasing complexity are gradually introduced.										M
R.21 The system shall provide access to a variety of educational materials in different formats	*R.21.A* - The student shall have access to different learning materials, including textual documents, as well as videos and audios.	M	M	M	M	M	M	M		M	M
	R.21.B - The teacher shall be able to have access to other teachers' learning materials.	D	D	D	D	D	D	D		D	D
	R.21.C - Visual formats should be prioritized in respect to textual formats.	D	D	D	D	D	D	D		D	D
R.22 The system shall support communication and exchanges among the different actors in the learning process	*R.22.A* - The system shall be able to allow group work/learning.	M	M	M	M	M	M	M		M	M
	R.22.B - The teacher/student/researcher shall be able to communicate with other registered users of the platform with tools, such as email, forum, etc.	M	M	M	M	M	M	M		M	M
R.23 The system shall give the ability to its users to enter marks and lyrics /modern musical notation in to the Text to Song tool and will produce the resulting chant /musical piece (while the tool annotates the current singing word/phrase)	*R.23.A* - The system shall give the ability to its users to enter marks and lyrics into the Text to Song tool and encode them in a MusicXML file	M		M							
	R.23.B - The system shall alternatively read lyrics and try to match them with a suitable musical lines and rhythmic sections, and encode them in a MusicXML file	M									
	R.23.C - The system shall parse lyrics and musical notes from a MusicXML file and synthesize the corresponding musical piece or chant	M		M							
R.24 The system shall allow students to make choices related to the educational path	*R.24.A* - The system shall allow the student to choose a specific learning path according to the style to be interpreted (rhythms or general sounds).				M						
	R.24.B - The system shall enable the student to choose a specific lesson.	M	M	M	M	M	M	M		M	M
	R.*24. C* - The system should enable the student to set a difficulty level.	D	D	D	D	D	D	D		D	D
R.24 The system should allow recording of sounds and comparison with another existing recording	*R.24.A* - The student should be able to record his/her voice and the system compares the related pitch with the one produced by a master singer.	D	D	D	D						
	R.24.B - The student should be able to record his/her voice and the system compares the related sound with the one produced by a master singer.	D	D	D	D						
R.25 The system should provide acoustic examples for CMC	R. 25. A - The system should provide acoustic examples for CMC									D	
R.26 The system should provide examples on breathing techniques, lip position and tongue articulation for HBB	R.26. A - The student should be able to see examples on breathing techniques, lip position and tongue articulation for HBB.				D						
R.27 The system should provide anatomo-physiological explanations for HBB	R.27.A - The student should be able to have anatomo-physiological explanations for HBB.				D						
R.28 The system should provide a tool for annotation of resources	R.28.A - The user should be able to annotate text, audios, videos, etc.	D	D	D	D	D	D	D	D	D	D
	R.28.B - The user should be able to annotate the text for further acoustical analysis and synchronisation with physiologic data (laryngeal signal, tongue and lip position)	D	D	D	D						

General category	Requirement	S1	S2	S3	S4	D1	D2	D3	D4	M1	P1
R.29 The 3D module shall make use of gaming strategies to enhance fun and motivation	*R.29.A* - The platform shall make use of gaming strategies (such as scoring, etc.) to enhance fun and motivation.	D	D	M	M	M	M	M		M	M
R.30 The 3D module shall provide detailed instructions about sensors, games and single activities	*R.30.A* - The platform shall provide detailed information about the type and function of the sensors (by means of a video tutorial, a virtual tutor, etc…).	D	D	M	M	M	M	M		M	M
	R.30.B - The platform shall be able to provide adequate instructions on how to use the game, what are the objectives, etc.	D	D	M	M	M	M	M		M	M
	R.30.C - The platform shall provide instructions about each single activity before allowing to start it (by means of a tutorial, a virtual tutor, etc…).	D	D	M	M	M	M	M		M	M
R.31 The 3D module shall offer a structured learning environment	*R.31.A* - The platform shall enable the learner to observe the expert performing the ICH in the "Observe" environment.	D	D	M	M	M	M	M		M	M
	R.31.B - The platform shall enable the learner to practice the ICH in the "Practice" environment.	D	D	M	M	M	M	M		M	M
	R.31.C - The "Practice" environment should allow the learner' to watch/listen to the expert's performance and then - at a given time - start practlcing it.	D	D	M	M	M	M	M		M	M
	R.31.D - The platform shall allow the performance to be divided into single entities.	D	D	M	M	M	M	M		M	M
	R.31.E - The platform shall be able to offer a sequence of activities with incremental difficulty.	D	D	M	M	M	M	M		M	M
	R.31.F - The platform shall envisage a final exercise, where the single entities are integrated, in the form of a Final Challenge.	D	D	M	M	M	M	M		M	M
	R.31.G - The platform shall be initially focused on gestures and the music shall be introduced afterwards.					M	M	M			
R.32 The 3D module shall display a video of a real expert	*R.32.A* - The platform shall display a video of the expert performing correctly in the "Observe" environment	D	D	M	D	M	M	M		M	M
R.33 The 3D module shall display specific parts of the body (also the inner parts) of the 'real' user	*R.33.A* - The platform shall display the lips of the expert.	D	D	D	M						
	R.33.B - The platform shall display the 3D model of the tongue of the expert.	D	D	D	D						
	R.33.C - The platform shall display the ultrasound image of the vocal tract of the expert.	D	D	D	M						
	R.33.D - The platform shall display the lips of the learner.	D	D	D	M						
	R.33.E - The platform shall display the 3D model of the tongue of the learner.	D	D	D	D						
	R.33.F - The platform shall display the ultrasound image of the vocal tract of the learner.	D	D	D	M						
	R.33.G - The platform shall allow to focus on the face of the virtual expert presenting appropriate facial movements.	D	D	D	M						
	R.33.H - The platform shall display the upper part of the body of the virtual expert in the correct posture.	D	D	D	M					M	M
R.34 The 3D module shall display a virtual character	*R.34.A* - The platform shall display the virtual expert performance in the main screen in the "Observe" environment.	D	D	D	M	M	M	M		M	M
	R.34.B - The platform shall display the virtual expert performance in the main screen in the "Practice" environment.	D	D	D	M	M	M	M		M	M
	R.34.C - The platform should display a virtual character performing the student's movements in the "Practice" environment..					M	M	M		M	M
	R.34.D - The platform should display a virtual character performing the student's sounds.	D	D	M	M						
	R.34.E - The platform shall allow to focus on the virtual expert's showing the correct legs movements.					M	M	M			
	R.34.F - The platform shall allow to focus on the virtual expert's feet showing the correct feet movements.					M	M	M			
	R.34.G - The platform shall allow to focus on the hands of the virtual expert performing the task in the correct way.									M	M
	R.34.H - The platform shall allow to focus on the fingers of the virtual expert performing the task in the correct way.									M	M
R.35 The 3D module shall allow personalized choices	*R.35.A* - The platform shall enable the user to select specific movements for training.					M	M	M			
	R.35.B - The platform shall enable the user to choose a specific activity.	D	D	M	M	M	M	M		M	M
	R.35.C - The platform shall enable the user to set a difficulty level.	D	D	D	D	D	D	D		D	D
	R.35.D - The platform should offer personalized training style.	D	D	D	D	D	D	D		D	D
	R.35.E - The platform should adapt the difficult level dynamically.	D	D	D	D	D	D	D		D	D
	R.35.F - The platform shall give the possibility to set individual preferences as to language.	D	D	M	M	M	M	M		M	M

	R.35.G - The platform shall give the possibility to set individual preferences as to the type of feedback.	D	D	D	D	D	D	D		D	D
	R.35.H - The platform shall give the possibility to set individual preferences as to the type of sensors.	D	D	M	M					M	
	R.35.I - The platform shall give the user the possibility to choose the sensors' window to be displayed.	D	D	M	M					D	
R.36 The 3D module should allow interactivity	*R.36.A* - The platform shall support interactive functionalities to facilitate learning.	D	D	M	M	M	M	M		M	M
	R.36.B - The platform shall allow the learner to pause the virtual expert's performance.	D	D	M	M	M	M	M		M	M
	R.36.C - The platform shall allow the learner to see again the performance of the expert as many times as she wants, based on her own choice.	D	D	M	M	M	M	M		M	M
	R.36.D - The platform shall enable a 3D view of the virtual character with possibility to zoom in/out.	D	D	D	D	M	M	M		M	D
	R.36.E - The platform should enable the user to rotate the virtual character.					M	M	M		M	D
R.37 The 3D module should allow the recording and replaying of sounds/movements	*R.37.A* - The platform should be able to record, store and replay the student's performance.	D	D	M	M	M	M	M		M	M
R.38 The 3D module shall provide students with appropriate formative feedback	*R.38.A* - The platform shall be able to provide visual or audio feedback.	D	D	D	M	M	M	M		M	M
	R.38.B - The platform should show the correct gesture in parallel to the student's one (phantom mode), so that the student can watch and imitate at the same time.					M	M	M			D
	R.38.C - The platform should show a spectrogram displaying the pitch values of the learner and expert performances as two different coloured waveforms with feedback purposes.	D	D	M	D						
	R.38.D - The platform should provide feedback after the whole dance is completed.					M	M	M			
	R.38.E - The platform should provide feedback after each dance figure.					M	M	M			
R.39 The 3D module shall envisage that assessment of students' performance is carried out	*R.39.A* - The platform shall be able to determine an evaluation score depending on the correctness of the user performance.	D	D	M	M	M	M	M		M	M
	R.39.B - The platform set up shall foresee that the learner proceeds in the platform only if he crosses the established threshold.	D	D	M	M	M	M	M		D	M
R.40 The 3D module should allow to compose a musical piece through the intangible musical instrument	*R.40.A* - The platform shall be able to produce synthetic sounds corresponding to the detected hand gestures.									M	
	R.40.B - The platform shall be able to allow more freedom of gestures compared to the real piano.									M	
R.41 The platform shall provide a visualization of the sound(s)/texts to be produced	*R.41.A* - The platform shall provide a karaoke-style visualization of the sound(s) to be produced.				M						
	R.41.B - The platform shall provide a videos presenting the byzantine music scores (partitura), i.e.the sequence of "Neumes".			M							
R.42 The platform should provide a metronome (both video and sound)	R.42.A - The platform should provide the sound of a metronome, along with a video to indicate the beat of the music.	D	D	M	D						
R 43. The platform shoulld provide a Generic Dance Game able to allow the creation of new dance gmaes	R.43.A - The platform, through the Generic Damce Game, should support selection between different avatars					M	M	M			
	R.43.B - The platform, through the Generic Damce Game, should support selection between different game environments					M	M	M			
	R.43.C - The platform, through the Generic Damce Game, should support selection between different evaluation algorithms					M	M	M			
	R.43.D - The platform, through the Generic Damce Game, should allow the user to include music (mp3 files) to specific exercises					M	M	M			
	R.43.E - The platform, through the Generic Damce Game, should support recording skeleton data from Kinect sensor					M	M	M			
	R.43.F - The platform, through the Generic Damce Game, should support recording skeleton data from other mocap sensors					D	D	D			
	R.43.G - The platform, through the Generic Damce Game, should support recording video from Kinect and/or other optical cameras recognized by Windows (e.g. USB cameras).					M	M	M			
	R.43.H - The platform, through the Generic Damce Game, should support loading data from mocap recordings in different formats (e.g. bvh, c3d, etc.)					D	D	D			
	R.43.I - The platform, through the Generic Damce Game, she Game Design interface should be easy to use.					M	M	M			

General category	Requirement	S1	S2	S3	S4	D1	D2	D3	D4	M1	P1
R.44 The web platform shall allow multilingual and Universal Access	*R.44.A* - The platform shall provide multilingual and universal access to the contents.	M	M	M	M	M	M	M	M	M	M
	R.44.B - The system should have high contrast themes with large fonts to aid people with visual impairment.	M	M	M	M	M	M	M	M	M	M
R.45 The web platform shall be a highly customizable operating environment according to distinguished user roles.	*R.45.A* - The platform shall be a highly customizable operating environment according to distinguished user roles.	M	M	M	M	M	M	M	M	M	M
R.46 The web platform shall provide catalogued information and materials about each ICH	*R.46.A* - The system shall be able to provide unique and unbiased ICH-related information/materials.	M	M	M	M	M	M	M	M	M	M
	R.46.B - The system shall be able to provide specific and detailed information about each ICH (i.e. history, origins, costumes, different styles, diffusion, ...).	M	M	M	M	M	M	M	M	M	M
	R.46.C - The system shall be able to provide an adequate number of external links to websites and other repositories promoting ICHs.	M	M	M	M	M	M	M	M	M	M
	R.46.D - The system shall be able to provide contents organized by thematic sections.	M	M	M	M	M	M	M	M	M	M
	R.46.E - The system shall provide access to different material formats e.g. text, audio, video, 3D, etc.	M	M	M	M	M	M	M	M	M	M
	R.46.F - The system shall give priority to visual materials rather than textuals materials.	M	M	M	M	M	M	M	M	M	M
R.47 The web platform should provide repositories of recordings, texts, scores, etc. for the different ICHs	*R.47.A* - The system shall provide a repository of contemporary musical scores.									D	
	R.47.B - The system should provide a repository of Human Beatbox rhythms and standard songs.				D						
	R.47.C - The system shall provide a repository of song/chant texts.	D	D	D							
	R.47.D - The system should provide rare Human Beatbox audio or video recordings that are not available on traditional communication channels, and be able to give new approaches of the present art (novel inspiration).				D						
	R.47.E - The system should provide audio or video recordings not found or rare on the one hand, and the origin and inspiration and translations of texts on the other hand.	D	D								
R.48 The web platform shall allow searching the available info and data using different criteria and parameters	R.48.A - The system shall be able to provide consistent results to the user queries.	M	M	M	M	M	M	M	M	M	M
	R.48.B - The user shall be able to search using a variety of criteria, e.g. time, geographical region, style, technique, rythm, performer/group, motion pattern, body/hand posture, dance figure, etc.	M	M	M	M	M	M	M	M	M	M
R.49 The web platform shall allow visualization of search results in different formats	*R.49.A* - The system shall visualize the search results graphically (other than text).	M	M	M	M	M	M	M	M	M	M
R.50 The web platform shall include communication features	*R.50.A* - The platform shall give the user the opportunity to get in contact with people performing the expression s/he is interested in.	M	M	M	M	M	M	M	M	M	M
R.51 The web platform shall allow enriching the range of the ICHs considered	R.51.A - The system should allow adding new sub-use cases and related info and data on the archive.										