Scientific Architecture of the educational toolkit of the project EDICULA

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Abstract. A major challenge worldwide is to promote cultural heritage protection as a lever for the enhancement of the society's identity and the integration of 'culture as an enabler for sustainable development'. The EDICULA "Educational Digital Innovative CUltural heritage related Learning Alliance" is a Strategic Partnership for Higher Education in Erasmus+ that aims to provide new knowledge in the field of cultural heritage protection that breaks the boundaries of science and engineering and be integrated in education. The EDICULA address this through the tow educational toolkits for the general public and for more restricted audience such as scientists and stakeholders. An educational framework to advance scientific transdisciplinary synthesis developed based on the interdisciplinary collaboration among the sectors of applied sciences in the protection of monuments with humanities disciplines using XR technologies, to develop. The architecture of the EDICULA toolkits emphasize the instrumentalization of this transdisciplinary collaboration through education, with the various universal educational tools and the experience from the emblematic rehabilitation of the Holy Aedicule of the Holy Sepulchre acting as common base.

Keywords: EDICULA, Cultural Heritage, Educational platform.

1 Introduction

The protection of Cultural Heritage (CH) assets is a comprehensive, interrelated and often contradicting collection of decision making processes, activities and assessment procedures. The EDICULA (Educational Digital Innovative CUltural heritage related Learning Alliance) project [1] is an innovative approach that fuses the interdisciplinary collaboration among the sectors of applied sciences in the protection of monuments with humanities disciplines using Extended Reality (XR) technologies, to develop an educational framework to advance scientific transdisciplinary synthesis. The innovation of the EDICULA project is that it emphasizes that this transdisciplinary collaboration can be instrumentalized through education, with the various universal educational tools and the experience from the emblematic Holy Sepulchre rehabilitation acting as common base.

The EDICULA project taking as a starting point the emblematic rehabilitation of Holy Sepulchre [2-4] aims to promote cooperation between Universities, stakeholders

and SMEs in the field of CH protection and to fuse the interdisciplinary and innovative research in the rehabilitation of the Holy Aedicule, its context and setting, to trans-cut with the history of architecture in Jerusalem. EDICULA aims to create immersive and interactive educational material by using Augmented Reality (AR) technologies. It will also reform the curricula of the three participating postgraduate programs, develop a Teacher's course for higher education teachers that promotes transdisciplinary scientific synthesis as a key element for innovative education, organize hands-on and immersive experience multiplier events and special conference sessions.

EDICULA aims to develop an open e-courses platform that addresses key issues in the rehabilitation, protection and sustainability of CH, and disseminates valuable knowhow and experience both to the wide audience as well as to CH stakeholders, scientists and professionals. The fundamental characteristic of this platform is that it will promote a holistic approach for transdisciplinary documentation, without, however, becoming too complicated. The key issues addressed relate to the enhancement of the educational aspects of engineering innovation; the emergence and establishment of transdisciplinarity as a fundamental trend in the protection of monuments; the capabilities of multi-modelling methodologies for multi-discipline management and analysis of knowledge; the capabilities of Augmented Reality (AR) and Virtual Reality (VR) to effectively diffuse information for social responsibility and awareness.

These key issues set the basic challenges for a purposeful design of this toolkit. Due to the wealth of knowledge and expertise, as well as the wide range of the thematic subjects that are relevant to the protection of Cultural Heritage, such a platform cannot aim to become just a detailed depository of knowhow and data; regardless how feasible this could be. Instead, the selection of its thematic subjects and the way they will be presented to the users of this toolkit, must be governed by the educational needs such a platform aims to address. The EDICULA educational toolkit consists of two modules:

- EDICULA-4-all educational toolkit, addressed to the wide audience (open access), including basic level of information. It supports only a limited number of scientific data, can be transferred in life-long learning and school education, demonstrating the effectiveness of transdisciplinarity in fusing science into general knowledge.
- EDICULA+ educational toolkit, which is the advanced module (registered access), addressed to scientists and experts in the field of protection of monuments with a relevant background. It provides knowledge with more scientific details and encompasses advanced information, relevant studies, scientific papers, data and metadata of the knowledge gained by the consortium in the emblematic restoration of the Holy Sepulchre. It can be transferred to professional and university courses for architects, archaeologists, conservators, students in arts and other relevant engineering disciplines, demonstrating the need for a new teaching framework that promotes cooperation and utilizes complementarity between diverse disciplines.

2 Methodological approach for the architecture of the EDICULA Educational toolkit

The careful design of the architecture of the educational toolkit emerges as the initial crucial step for its successful development. Important issues that drive its development include: the target groups that the EDICULA toolkit will be addressed to; the content (thematic areas) of the EDICULA toolkit; the toolkit-to-user information presentation approach and educational aspects; the semantics and ontology of the toolkit content and its management; the Artificial Intelligence (AI) module for classification of different data and metadata; and the technical requirements for the creation and operation of this educational toolkit.

The architecture of the educational toolkit will conform to the following fundamental prerequisites: (i) provide flexibility through its e-learning platform, enabling easy navigation and immediate access to all main categories and activities of the toolkit; (ii) no previous knowledge in cultural heritage or its rehabilitation is required to assess EDICULA-4-all; (iii) EDICULA+ will provide an easy sequential learning progress, divided into basic and advanced modules, enabling the end-users to experience a learning procedure. The following presents the development stages for the EDICULA educational toolkit.

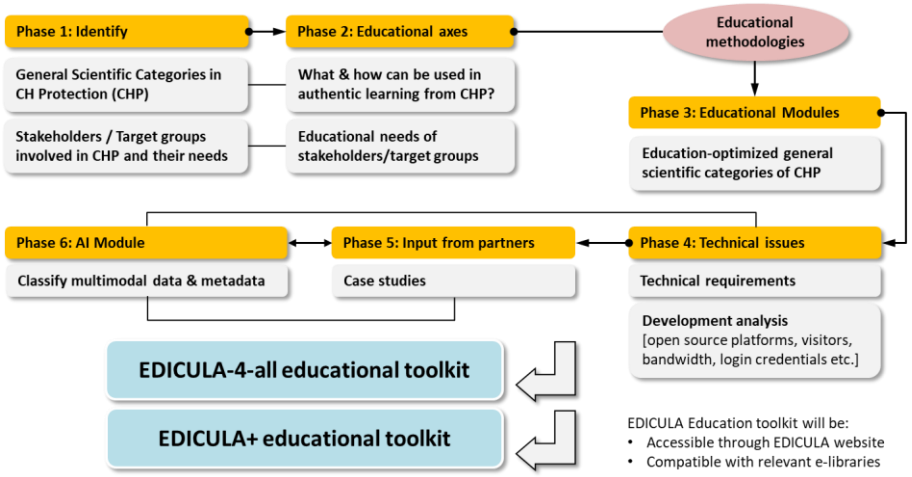

Fig. 1. Development stages for the EDICULA educational toolkit

The architecture of the two toolkits is such that platform will include lectures and virtual laboratories, videos, lecture notes, and other types of educational material. However, it has been recognized that the diversity of types, size and presentation specifications of the aforementioned educational material and media, despite its desired advantages, inevitably creates diverse technical requirements that the architecture of the educational platform must identify, evaluate, integrate and conform to. Moreover, an AI module will aid and facilitate classification of multimodal data and

metadata for data storage and retrieval, in a more reliable and transferable approach, compared to the conventional subjective and expert oriented methodology.

3 Development of the thematic nodes of the EDICULA toolkits

The protection, rehabilitation and the enhancement of the sustainability of Cultural Heritage assets is a comprehensive, interrelated and often contradicting collection of decision making processes, activities and assessment procedures. As clarified above, the EDICULA Toolkits, in both their forms, do not aim to function as a one-stop depository of all the wealth of use cases and the vast array of activities related to the subject. This is indeed a huge undertaking and does not actually offer a significant educational value. Instead, the toolkits aim to introduce the users in the process of understanding the complexity of the protection of Cultural Heritage and provide them with the appropriate training to address the related challenges.

Although the toolkits cannot and do not need to cover all potential use cases and CH related activities, they still need to be structured around a core collection of typical processes and activities for which characteristic use cases and educational material can be provided, as a guide for further elaboration and as a starting point for the users. This collection of thematic nodes largely defines the extent and complexity of the toolkits and the interrelation of its modules. Many thematic areas are interdisciplinary and trans-cut various subjects. The challenge, thus, is how to describe subjects that are relevant to many thematic areas, without reverting either to focused and specific analyses or to extensive interlinking.

The approach adopted in the EDICULA toolkit is a hybrid one: The educational material for each thematic subject is developed in such a way that the user realizes that the technique or process is “seen” from the perspective of the specific thematic area, however, it may be relevant for other thematic areas – through a different perspective – for which appropriate linking is provided.

In this framework, the first stage of the development of the thematic nodes was to decide upon the main pillars (groups). These groups follow the general flow of activities. Initially, one needs to understand the “problem”. Based on this understanding, decisions then need to be taken, whether or not to proceed with a “solution”. An appropriate “solution” must be sought and implemented, followed by the last step of ensuring the future of the CH asset. The four pillars are more appropriately described as 1st level thematic nodes (1st level TN): (A) Analysis of the CH asset; (B) Decision making; (C) Interventions; (D) Sustainability

3.1 Analysis of the CH Asset

The analysis of the CH asset takes into account the structure itself, the surrounding environment, time and values. A historical building or a monument must be seen as the result of a continuous process of history imprinting upon its structure and of an unavoidable interaction with its natural and anthropogenic environment. Also information about them is not readily available, but instead needs to be “extracted” from

them through many complementary approaches. These approaches are presented in the toolkits through a series of 2nd level thematic nodes.

Specifically, while envisioning a general timeline-type approach, the archaeological study is a typical thematic area relevant to the analysis of the CH asset. It regards archaeological excavations, archaeological surveys and conservation activities related to archaeological sites. The archaeological issues will be presented with emphasis on Technology and with use cases and educational material for conservation activities.

In a similar manner, historical documentation will focus on the technology of archiving, organization of libraries (digital libraries and scientific publications) and the latest advancement of Information Technology. Historical Documentation is an important element in the analysis of a CH asset, but the process of searching, retrieving and utilizing historical documentation is valid for other relevant scientific disciplines in general.

An important part of the analysis of the CH asset is its architectural analysis. This can be approached in three main groups: (a) Historic cities; (b) historic buildings and monuments; (c) cross-cutting digital technologies for documentation and modelling. The architectural analysis of architectural is an important thematic area, useful for other engineering disciplines too, e.g. the constructional analysis and documentation, which can be approached through the perspective of architecture. Obviously all these thematic areas are interlinked with other thematic nodes, such as Diagnosis or Structural analysis – assessment, which approach the same subject from other perspectives.

Geometric documentation **a** thematic node with an intense IT content, will cover subjects of passive and active methods of data acquisition, advanced processing of data and the latest advancements in the creation of geometric documentation products.

Materials are studied in the toolkit through a series of interlinked roles they play in a CH asset. Materials can function as building elements in a structure. They can also have a decorative role. But materials also interact with the environment, creating new decay products and damage to the CH asset. This interaction with the environment necessitates the study of the various categories of restoration materials, the main consolidation, strengthening, conservation and protection materials and techniques, and of course the emerging role of smart and advanced materials and techniques. The various categories of materials, understandably regard a vast number of materials and relevant information, which need not and will not be covered in its entirety. Materials science is an extensive scientific discipline that requires in-depth understanding of its interaction with other disciplines. The EDICULA educational toolkit does not envision achievement of such a full analysis, neither it is required for all target groups (especially the wide audience). Therefore, the selected materials and applications of technological advancement will constitute the principal tool in understanding the often-underestimated role that the materials play in the operation and sustainability of our built environment, including CH. The trans-cutting, interdisciplinary importance of non-destructive testing (NDT) for assessment and evaluation of materials and interventions will be presented through use cases and relevant educational material.

The five aforementioned thematic nodes effectively largely focus on the CH asset itself. However, as in any ordinary structure or infrastructure, the environment is a crucial factor that influences the operation and state of the CH asset. The various en-

vironmental loads acting upon the CH asset include the atmospheric pollution, water interaction, earthquakes, climate change and anthropogenic impact, in correlation with risk assessment and management and assessment of their impact on CH assets.

Supporting all these, an important technology-intensive thematic node regards diagnosis**.** This refers to a methodological study of the decay and damage. Decay refers to the identification, classification and documentation of decay patters, their mapping with NDTs, modeling of the decay and evaluation of the susceptibility of materials to decay factors. Also, it includes identification of damage patterns, its mapping by NDTs and identification and evaluation of their causes and mechanisms. Diagnosis provides the necessary information to assess the preservation state of the CH asset and to assess the environmental impact, both with a strong mapping and data-management character.

Similarly, the analysis and assessment of the structural behavior of the CH asset is crucial, obviously related to the asset itself and its interaction with the environment, and includes analytical structural and assessment methods (laboratory testing and structural assessment), structural health monitoring technologies, numerical approximation methods and an array of techniques utilized for earthquake engineering.

The CH asset, however, is not only a tangible entity, but equally important it carries values. This thematic issue, regards issues of authenticity and compatibility of past interventions. The assessment of the CH asset is concluded by addressing subjects relevant to knowledge-based digital infrastructure. This is a critical component of advanced assessment campaigns, as exemplified by the experience from use case of the rehabilitation of the Holy Aedicule, due to the need to fuse, manage and present large amounts of multi-spectral and multi-modal data. To some extent, this thematic node reflects the emerging need for efficient state-of-the-art user-interface, with emphasis on 3-D representations, virtual reality and augmented reality.

3.2 Decision Making

Decision making is a poly-parametric process that involves many stakeholders in CH. It builds upon the knowledge gained from the previous thematic nodes and can be broken up into five general categories. The first one regards all the relevant studies (architectural, structural, materials and interventions, other). These form the "input" elements, in a condensed form, for the decision making process, i.e. whether to intervene or not. Another thematic node, regards the legislation framework, to which any decisions must adhere to.

An important 2nd level TN regards the various categories of stakeholders: Ministries and national bodies, regional and local authorities, society/wide public, religion stakeholders, private entities and persons, NGOs, and the scientific and technical communities, all of which create a complex matrix of responsibilities and interest. Moreover, the socio-economic and technical framework needs to be described, that highlights how cultural heritage is perceived by Society, how it is related with Tourism and local development (especially historic cities) and how all relevant activities can be financed. Also, thematic nodes need to be included that describe the role and limitations of Science and Technology that often drive any relevant decisions. Finally,

the EDICULA toolkit analyzes how CH is protected in areas of conflicts and how cooperation challenges with relevant authorities and stakeholders can be addressed.

3.3 Interventions

The third 1st level TN compiles and describes all the necessary steps for implementing any interventions required and decided upon from the two aforementioned thematic nodes. The initial stage of such a comprehensive array of task regards, obviously, the design of interventions. This 2nd level thematic node covers all relevant issues ranging from the organization of the worksite and in-situ laboratories and workshops, the logistics of materials and equipment, human resources, detailed planning and detailed pre-description of all necessary stages. These are presented through real use –cases, such as the rehabilitation of the Holy Aedicule.

The integrated governance of such projects is discussed, since these are thematic subjects not often well understood, despite their importance. Similarly, risk management and contingency planning of the actual interventions works must be taken into account, to cope with real-world uncertainties. Following the careful planning, the next stage in typical CH projects is the design, implementation, assessment and comparative evaluation of pilot-scale works. The use-case of the Holy Aedicule rehabilitation is a characteristic example, which underlines the importance of pilot works in the optimization of interventions prior to their actual implementation.

Another thematic area regards the main issues related to the implementation of interventions. Obviously, with such a large variety of CH use cases it is not feasible, nor desirable to describe in detail all potential interventions. However, these can be categorized in intervention aiming to assure structural integrity, to reveal and preserve the values, and to enhance the sustainability of the CH asset. Digital depositories are described as the latest essential tool for the documentation of works.

It is important for all target groups to realize that CH protection does not end upon implementation of any designed interventions. In fact, the assessment and evaluation of interventions, both during their implementation as well as after the finalization of work, is equally important and a crucial element in decision making. To this end, criteria for assessment and evaluation must be set, regarding the compatibility, performance, authenticity and integrity that can often shift necessary decisions to alternative interventions approaches. The joint importance of in-situ utilization of advanced NDTs and conventional testing will be underlined, as well as the concurrent validation of the response of the retrofitted structure by modeling.

In fact, as experience from a variety of use cases has shown, the actual implementation of interventions can lead to the revealing and preservation of values. New findings are revealed and documented during the implementation of works, or during parallel or post-works analysis of new data. These require optimization of interventions to ensure preservation of values, which in turn require comprehensive risk analysis for the preservation of values, as well as design, implementation and documentation of relevant mitigation & protection measures. Communication strategies must be adopted to effectively disseminate such findings to the media and to the society.

3.4 Sustainability

CH assets must be preserved for future generations, and in this context they differ from ordinary buildings and infrastructure which are designed and operated within predefined lifetimes. Therefore, the concept of sustainability is of utmost importance and entails a series of activities. Foremost are the activities that regard monitoring of the CH asset, where critical parameters are set and monitored, through permanent sensors and instrumentation or through regular scientific surveys. Similarly, monitoring of the environment can provide crucial information that can influence the state of preservation of the CH asset or its behavior to environmental loads. In addition, in certain cases, maintenance of the CH assets is performed through a strategic planning that includes preventive and regular maintenance schemes, prioritization procedures and interaction with the Society. In an analogous approach, environmental management can provide "solutions" for interventions to the CH asset's environment to minimize or control the impact. It should, however, be realized that sustainability is not an issue of the CH asset or its environment, but it is an issue on how Cultural Heritage is perceived and coexist with the Society. In this framework, dissemination and communication activities play an important role nowadays, and enhance the dialogue between Science, relevant authorities and the Society, ensuring a bilateral effective integration of cultural heritage in the socio-economic development. A typical example, which will be addressed in the EDICULA toolkit is the role of Tourism. Moreover, sustainability is indirectly and long-term enhanced through Education. By ensuring that the right professionals are taking the right decisions, and by ensuring that the general public understands the importance and the challenges involved in the protection of our CH, Education can emerge as the fusion tool for all this knowledge.

4 The generic core and the thematic nodes

The architecture of the two EDICULA toolkits is derived from the generic core, which comprises the list of the thematic components and the structured table of generic features, using the "functional, data, enabler" attribute, and the mutated relevant project features. A critical step in the definition of the architecture, thus, is to define the components' features, using certain rules. As described above the thematic components can distinguish four groups of thematic components: the natural environment, the man-made environment, the disciplines involved and the interventions required or implemented.

The generic core comprises all the thematic components and their features. Each thematic component has one or more generic features. An example of a generic component is "nondestructive testing", and a "child" generic feature "thermographic analysis". The granularity of components and features is relevant to the total number and the overall complexity of the educational toolkits. It should be clarified that a generic feature belongs to one and only one thematic component. As mentioned earlier, although certain thematic subjects (e.g. a technique) are relevant to many thematic components, it should always be "approached" from the perspective of these specific the-

matic components, in order to maximize its educational value and learning "footprint" to the specific target groups.

A generic feature has attributes that provide information about it and help to classify it. A very important step for the development of the architecture is the definition of "functional, data, enabler" attributes. A feature can be of one and only one of the following three types:

- A functional feature is a package of functionality relevant to the component to which it belongs. As an example, a Microsoft PowerPoint presentation of thermographic analysis is a functional feature of the thermographic analysis component.
- A data feature refers to how the component uses data. An example is the classification of different data and metadata.
- An enabler feature refers to the technical elements that enable the component. An example is the educational software that supports the preparation and packaging of a short introduction to thermographic analysis

A functional feature addresses the needs of a specific user group and is always linked to at least one enabler feature which enables it, i.e., makes it available for use to the users. Each functional feature must be described with emphasis on what the user does, what are the results, if any, and whether it is linked somehow to other functional features, forming in a sense a "chain", or a "set". Examples of functional features are lectures and virtual laboratories, videos, lecture notes.

Two types of data will be included in the toolkits: Static and dynamic data. Static data do not change as the toolkit gets used, i.e., as the user groups use the available functional features. Dynamic data, on the other hand, are generated using the toolkit, i.e., are the result of the users using one or more functional features. A data feature may be related to one or more functional features. There may be data features that are not directly related to functional features, but to the overall use of the toolkit. An example is user authentication data. Each data feature requires an enabler feature which enables it, i.e., makes it available to the toolkit environment.

Enabler features comprise what we might call the "technology" layer of the toolkit. There are two groups of enabler features. One group is derived from the functional and data features. It is the group that "enables" these features. The other group is not linked to functional and data features. An example is the enabler that manages the user sessions. This enabler is independent of functional and data features. The definition of the generic core requires that at least one project core is also defined. The project core is analyzed, and the results feedback the definition of the generic core.

5 The effect of users' requirements on the toolkit architecture

The composition of the user groups of the EDICULA-4-all and the EDICULA+ educational toolkits is highly dependent on the user's needs and ambitions. The motivation to exploit these educational toolkits and benefit from their educational content does not rely only on issues of accessibility. Obviously the general public has different expectations and learning capacity compared to more specialized groups of users

such as CH students, professionals and experts. It is readily apparent that the social, educational, scientific and knowledge background of a user are crucial parameters that need to be taken into account, and addressed by the architecture of both toolkits. The challenge is how to categorize such a diverse variety of users, without resorting to exclusion issues or without ending in users losing their interest to use the educational toolkits either as a result of too much information or as a result of too little information.

The categorization of users takeσ into account that, fundamentally, the motivation to learn does not necessarily "coincides" with a user's intellectual or learning capacity. For example, we should not arbitrarily assume that a user loosely categorized as general public (e.g. a merchant, a lawyer etc), i.e. a person not directly related to the field of CH protection, that he or she may not have the intellectual or learning capability to process, analyze and synthesize specialized information more focused on CH issues. Conversely, a specialized user (e.g. a conservator, an archaeologist) may find useful the general information provided to the so-called "general public", as he or she may want to start understanding the field of CH protection from perspectives other than his or her expertise. On the other hand, the flow of information should be somehow tailored to the user's needs and intellectual capacity, since the unrestricted "overflowt" with information may end up emerging as an educational barrier to many users regardless of their intellectual capacity.

The categorization of users, should also be flexible. The educational toolkits, through their architecture, should allow the user to "navigate" between user categories, as required, not only through accessibility regulators but also through levels of educational contents. The following users groups have been defined:

General Public: Admittedly, this term is rather difficult to define, since it refers to citizens with a wide variety of social and intellectual skills. It basically refers to all citizens that do not have specialized knowledge in the field examined, e.g. CH protection. However, being such a generic term, it still refers to users with different needs and educational background. The general public needs to become aware that the social and educational value of European CH can actively contribute to job creation, economic growth and social cohesion. The essential requirement for the EDICULA-4-all educational toolkit, is therefore to be effective in raising awareness of the importance of Europe's CH through education, including activities to support skills development, social inclusion, critical thinking and youth engagement. The general public can be defined through two sub-groups:

- active citizens with basic interest in CH protection, who require basic information, with easy-to-understand terminology and user-friendly platform-user interfaces to allow them to "navigate" through various CH protection thematic areas.
- citizens with an economic interest in CH protection who want to utilize the EDICULA-4-all educational toolkit to become more acquainted with the issues related to CH protection from the perspective of business or economic opportunities.

Students. This is a very important wide-ranging sub-group of users with challenging educational needs. It includes students from elementary school up to post-graduate

students. Understandably the educational needs and intellectual capabilities depend on their educational level. However, the common issue for students of all levels is how to make CH protection, through the EDICULA-4-all educational toolkit, a useful instrument for their educational development. In fact, students will form the future experts and professionals in various fields and especially in the field of CH protection. Interdisciplinary and transdisciplinary cooperation of scientific and professional fields is a vital element and key enabler in CH protection and rehabilitation, and the vast experience from this field is diffused to the students through the educational toolkits. In addition skill development as well as a hands-on experience of all students is a prerequisite especially for those who will engage as professionals with cultural heritage related issues. The Youth today is very familiar with IT, especially AR, often much more compared to the general public. The educational toolkit exploit this "skill" focusing on media more familiar to the students, such as videos, AR or VR applications, or narrative-type diffusion of information.

Experts and professionals in CH-related stakeholders: The protection of CH is a complex and wide-ranging process for Society that is entrusted to various "stakeholders". CH assets are managed by Ministries of Culture, or corresponding regional authorities. Often, however, central responsibilities overlap with those of local authorities, such as municipalities or prefectures. A complex bureaucratic environment is unavoidably developed with often contradicting and unproductive interweaving boundaries of responsibilities. Furthermore, many stakeholders are staffed by personnel not fully trained on CH protection but rather apply ad-hoc their respective field of expertise. Stakeholder groups also include private owners and institutions which due to their limited human resources, may face acute diminishing of relevant expertise. Due to their varying level of skills, educational and scientific backgrounds, as well as the varying needs of members of this group, the toolkits are characterized by a dynamic flexibility, in the sense of providing the necessary information with the most appropriate user-optimized level of analysis.

Academic personnel and teachers: This group of users refers to those responsible for teaching the students and aid them utilize for their own studies the lessons obtained in the field of CH protection. This group includes elementary and high schools teachers, professional schools trainers and University-level professors. Obviously the scientific and educational background is varying but to some extent it addresses the needs of the respective level of students. The terminology and the educational content of the toolkits need to be adjusted accordingly. The educational level also influences the compilation and character of educational material that the teachers, trainers and professors need to utilize. A more pictorial and simplified type of educational material is required for elementary school teachers, not because they cannot understand the issues discussed, but because it is easier and more effective to transfer this type of information instead of asking them to analyse complex data and prepare their own educational material for distribution to their students. As the educational level is increased, the information is less generic, more focused, more detailed and requires more critical synthesis for the teacher/professor, while offering more opportunities to

ensue different directions. The academic personnel have more flexibility in integrating in their courses the experience in the field of CH protection, as presented through the EDICULA educational toolkits. In fact a Teacher's course will be organized as part of the EDICULA project. The wider availability and accessibility of the EDICULA toolkits enables them to support such a transformational process for other courses.

Researchers: The final group of users includes all researchers, whether these are affiliated to Universities or academic institutions, or whether they are employed in CH-related organizations such as Museums, but are not directly involved in decision-making processes for CH assets. These users are linked with Innovation and Research, at theoretical or experimental levels. The EDICULA+ toolkit, which is mainly relevant to Researchers, functions as the basis for Research in the field of CH protection, by providing a compact depository of relevant information with emphasis on IT, digitalization of techniques and data management, organization challenges of complex projects and a synthetic way of thinking. The interdisciplinarity of the field becomes evident through the educational material of the EDICULA+ toolkit, bringing together expertise from a variety of relevant scientific fields. Even more important, the scientific dialogue, as expressed by the Case Studies includes in the toolkit is a legacy for all Researchers utilizing this toolkit and a prerequisite for effective and open-minded Research

6 The presentation layer

The term "presentation layer" does not strictly refer to the toolkit-user-interface, in the sense of how the user sees the toolkit in front of his or her computer screen, but rather in the organization of the hierarchy of the toolkits' various components. Obviously, the general organization is driven from the selected thematic nodes, which structurally display a hierarchy in the subjects discussed. Also, as described earlier in the relevant section, these thematic nodes follow a typical "course of actions", i.e. some form of step-by-step procedures. Therefore, fundamentally, the thematic nodes already exhibit some form of hierarchy and drive a presentation approach that is incremental and evolutional. The role of the presentation layer is even more important, when the issues discussed in the thematic nodes is presented through specific projects. In these cases, the presentation layer acquires a central role, as it needs to allow the user to understand, analyze and dynamically learn from complex projects. These projects are characterized by a strong "interventions" character, although it is the role of the Educational Toolkits to highlight the processes required prior- and post- interventions that ensure an effective and sustainable solution to the issues involved.

In order to understand this, it should be reminded that a Cultural Heritage area may have many Sites. A prime example in the EDICULA is the Old City of Jerusalem. Each site of an area may have been the subject of one or more projects, as is the case with the Church of the Holy Sepulchre, in which many past and ongoing projects have been implemented. For example, the rehabilitation of the Holy Edicule is a project of

the Holy Sepulchre site. In this project the general object hierarchy "Area-Site-Project" is transformed to an Instance Hierarchy "Old City of Jerusalem – Church of the Holy Sepulchre – Rehabilitation of the Holy Aedicule". In these cases, it is more effective to approach the projects through an "area – site – project" hierarchy, rather than through analyses of the various disciplines and thematic nodes, as described in detail in the preceding sections.

7 Technical requirements

Platform goals: The main objective of the learning platform is to provide an easy-to-use set of tools to course creators in order to enable them to design their course as they originally intended and not have to make any major alterations in order to upload it into the platform (Fig. 2). Along with this, a set of different activity types had to be available for them to perform the different activities found within their courses, such as regular course content, forums for discussion, quizzes and multiple choice and content submission for assignments and other tasks.

The courses allow different user groups. Courses can either be taken by individual learners or groups of multiple users depending on the course creators' preferences, the type of activity being taken and the learning outcomes as defined by the course. The configuration and design of the EDICULA-4-all learning platform was implemented keeping in mind that the courses being made available for this project include asynchronous and synchronous methodology. The web-based educational material hosted on the public website of the EDICULA project allows sharing the results with the general public, interested users and with the EDICULA partners and beneficiaries. The dissemination of project results and scheduled events will be highly served by web-based means and mechanisms

Learning analytics: Another main objective of the EDICULA-4-all e-learning platform is the recording and visualisation of different learning analytics during the duration of a course. These analytics are then to be used as metrics for both the determination of the success of a course model and also evaluation of the platform as a whole. The platform needs to be able to record these different analytics without any additional work on the course creators' part to make sure that consistency will be kept for the evaluation of the courses. Different learning analytics tools record a whole range of data from the different activities and courses found within the educational platform.

EDICULA e-learning requirements: The e-learning environment is a web-based environment which contains the corresponding educational material for adults' education on Internet use. With this, the participating users educate, train and assess their knowledge on ICH topics, or contribute with training material on these topics. The requirements based on the main objectives of the e-learning environment fall into the thematic nodes described in the previous section.

8 Conclusions

The EDICULA educational toolkit departs from being a simple depository of information or a collection of pre-set lectures, videos and other educational material. By adopting a cultural heritage oriented architecture it manages to address challenging requirements and to serve the needs of a wide audience. The thematic nodes selected function as the core of the educational character of the toolkits, but their cross-linking nature, the interdisciplinarity they introduce and the way they are presented (AR, VR, e-learning) evolves them into crucial flexible and adaptable educational elements for further reading, study and analysis. This work demonstrates that the field of Cultural Heritage can be a useful starting point for educational needs, providing case-studies, methodologies and technological achievements relevant to other scientific fields and the society. More important, it highlights another important aspect of the field of CH protection, namely its educational character.

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