

# EDICULA

## Educational Digital Innovative Cultural heritage related Learning Activities

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**O1 EDICULA EDUCATIONAL TOOLKIT**  
**D1.2 Architecture of the EDICULA-4-all educational toolkit**  
NTUA  
26 April 2021



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## 1. Introduction

The EDICULA educational toolkit is the first Intellectual Output (O1) of the EDICULA project and regards an open source educational platform that addresses key issues in the rehabilitation, protection and sustainability of Cultural Heritage (CH) assets, 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 that this educational toolkit will address are related to:

- the enhancement of the educational aspects of engineering innovation
- the emergence and establishment of transdisciplinarity as a new 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 careful and 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.

Therefore, the EDICULA educational toolkit will cover the fundamental thematic areas relevant to CH, at an appropriate detail as required, through an educational-oriented approach that fuses different information and experience from various use cases into educational material that is optimally organized and disseminated. Most important, such a platform will not be simply a “stationary” depository of educational material, but on the contrary, it is designed such that it suits and addresses the specific needs of the various users/target groups. To achieve this, it will focus on the analysis and dissemination of state-of-the-art scientific transdisciplinary methodologies, and educate users on how to employ them in the field of CH protection, as well as to other relevant fields or use-cases.

### 1.1 Cooperation framework for the development of the Architecture of the EDICULA Educational Toolkit.

The EDICULA Educational Toolkits cover a wide range of thematic areas, relevant to the protection and rehabilitation of CH assets. The variety, as well as the special issues involved in these areas, demands a close cooperation between the EDICULA partners, with NTUA as the leader organization of O1, to bring together valuable expertise, but more importantly to identify those thematic areas that the EDICULA partners can mainly contribute to.

However, the thematic areas selected (see following sections) are not merely a collection of the individual partner’s specializations and expertise, but instead, the collaborative outcome of an effective discussion and balance between what is required for a comprehensive educational toolkit and what input the partners can provide to materialize this. During this cooperation, it was fundamentally clarified that the platform will be compiled by educational material tailored to the educational needs of the platform and not, instead, of plain use-cases descriptions. In this framework, the close cooperation of all EDICULA partners ensured that each partner can contribute to many more thematic areas compared to their own discrete expertise, in effect, being able to “approach” each thematic area from their point of view. This cooperation framework is



more effective, as it provides an opportunity for exchange of ideas and experiences, otherwise not feasible if an alternative compilation-based approach was selected.

The cooperation between partners was not limited to the thematic areas only. Active partners' participation ensured that the technical specifications of the EDICULA platform fully addressed the envisioned architecture of the toolkits. In turn, the selected technical solution to the platform formed the baseline upon which the thematic nodes, their interlinking and the type of educational material required were cooperatively defined.

The architecture of the EDICULA educational toolkits and the respective deliverables, were approved by all partners at the 2<sup>nd</sup> Steering Committee on 19 April 2021.

## 2. Methodological approach for the architecture of the EDICULA Educational toolkit

Based on the above, the careful design of the architecture of the educational toolkit emerges as the initial crucial step for its successful development. The following important issues drive its development:

- 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
- The technical requirements for the creation and operation of this educational toolkit.

A central decision in the EDICULA project is that the EDICULA Educational Toolkit consists of TWO MODULES, regarding the access level to target groups:

- **EDICULA-4-all educational toolkit**, addressed to the **wide audience** (with **open access**), including **basic level of information**.

*It supports only a limited number of scientific data and is also designed to support general information about the projects' objectives*

*It 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** (with **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 will encompass 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 addressed to 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*



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The architecture of the educational toolkit will conform to the following fundamental prerequisites:

- Provide **flexibility** through its e-learning platform, enabling **easy navigation and immediate access** to all main categories and activities of the toolkit.
- **No previous knowledge in cultural heritage** or its rehabilitation is required to assess **EDICULA-4-all**.
- **EDICULA+** will provide an **easy sequential learning progress**, divided into basic and advanced modules, enabling the end-users to experience a learning procedure.

A conceptual roadmap to the EDICULA Educational Toolkit is shown in the following schematic.

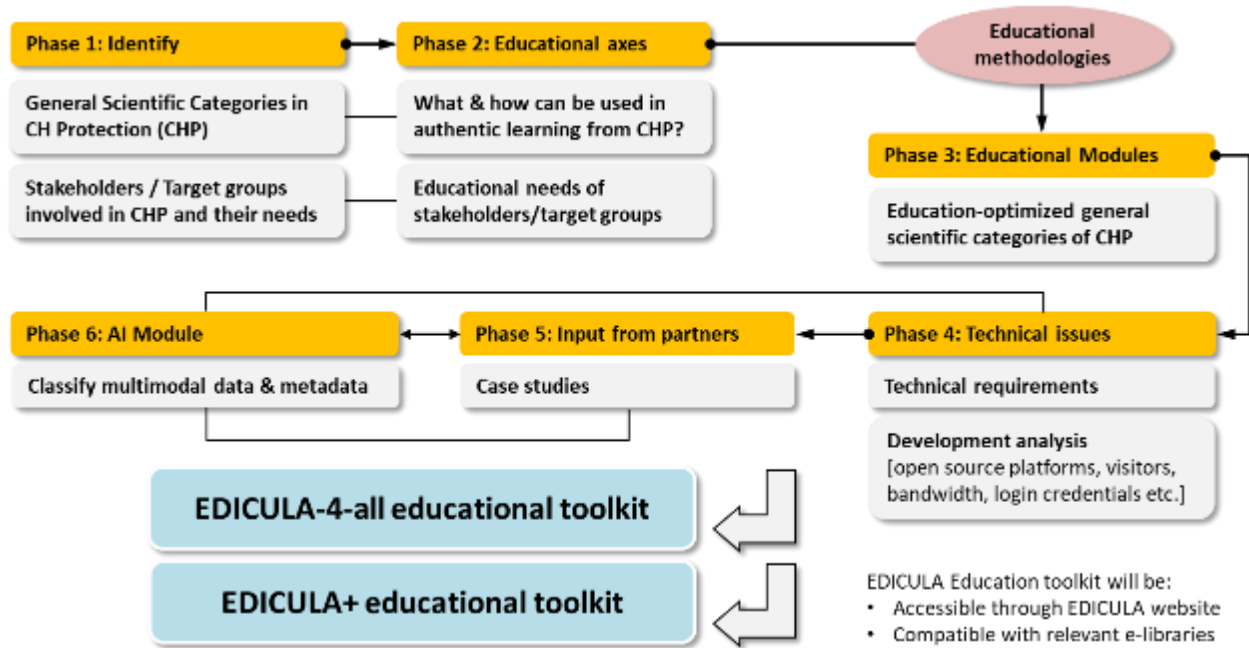


Figure 1. Conceptual roadmap for the EDICULA Educational Toolkit

It should be highlighted that the EDICULA-4-all and the EDICULA+ educational toolkits are based and developed on the same thematic content – ontologies, however through utilization and adaptation of different semantics and narration.

- *In the EDICULA-4-all educational toolkit the monument, the values, the aesthetics/architecture and the history are at the foreground.*
- *In the EDICULA+ educational toolkit, the various disciplines involved in CH protection, the relevant techniques and methodologies are at the foreground*

The methodology adopted and the involvement of all partners ensured that the architecture and the content of the EDICULA educational toolkit takes into account and address the wide range of all aspects relevant to Cultural Heritage protection, and that any technical difficulties are resolved early in the development phase (i.e. Tasks 1.3 – 1.5)

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 by the



EDICULA team 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** (Task 1.3) will be developed that 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**. Such an AI module, however, will not be a later add-on module on an established architecture, but instead, its function and outputs are provisioned and fully integrated in the architecture of the toolkits.

Based on the architecture of the EDICULA Education Toolkits considers some general issues, critical for the effective development of the platform and its evolution into a valuable educational toolkit.

#### **a. Commonality of the EDICULA-4-all and EDICULA+ toolkits**

1. EDICULA-4-all should NOT be simply a “light” version of EDICULA+, as this may hinder its efficiency for the wide audience.
2. A potential “merged – intermediate” toolkit should NOT be developed. This could “overshoot” the needs of the wide audience and “undershoot” the needs of scientists and experts.  
The two cooperating toolkits will be optimized each for the respective levels
  - ✓ *EDICULA-4-all addresses the basic needs of the wide audience*
  - ✓ *EDICULA+ addresses the more sophisticated needs of scientists and experts*
3. Certain technical features and information may need to be unique for each toolkit. Their respective architecture identifies them and cross-utilizes common technical features as needed.
4. Educational material may need to be duplicated and optimized for each toolkit (e.g. lectures, videos), based on the different needs and access level of the different target groups.
5. The AI module should be able to facilitate classification of multimodal data and metadata for data storage and retrieval from a joint database, but provides outputs specific to each toolkit.

#### **b. Parallel development**

6. The development of EDICULA+ will benefit from the experience gained from the PARALLEL DEVELOPMENT of the EDICULA-4-all, efficiently resolving common technical difficulties, whereas additional features of EDICULA+ will update EDICULA-4-all if required.

#### **c. Update potential**

7. The bilateral correlation and the “open architecture” of the educational toolkits should ensure that their updates are dynamic and continuous, and most importantly, adaptable to the different needs of the users.

#### **d. Adaptability potential**

8. The architecture and the development of the educational toolkits should not be bounded by the scientific background of the involved partners but should be adaptable to other use cases with different focus.

#### **e. Upgrade potential**

9. The dissemination of this educational toolkit will act as feed-back channel from experts and general public around the world, to improve the toolkits’ efficiency.





### 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 **1<sup>st</sup> level thematic nodes (1<sup>st</sup> level TN)**:

- (A) **Analysis of the CH asset,**
- (B) **Decision making,**
- (C) **Interventions**
- (D) **Sustainability**

Table 1 presents, collectively, the structure and hierarchy of the thematic nodes. The hierarchy (exemplified by appropriate numbering that aids the architecture of the educational toolkits and ensures unique identification of each thematic node) is evident in the Table.

*The detail and extent of the description of the use cases and the educational material must conform to a **fine balance between an exhaustive analysis** (and the risk for unnecessary specialization and loss of general ideas) **and a more general description** (and the risk for minimal understanding of the issues involved). This “dilemma” is, obviously, valid for all thematic areas described in the toolkit. Obviously the EDICULA+ educational toolkit will shift its focus on more detailed analyses, compared to the EDICULA-4-all which is instead focusing and presenting more general descriptions.*

The second stage regarded the analysis of these aforementioned groups. The **ANALYSIS OF THE CH ASSET** takes into account specific factors, i.e. the structure itself, the surrounding environment, time and values. A



historical building or a monument must not be seen as an ordinary building. It is, instead, the result of a continuous process of history imprinting upon its structure and of an unavoidable interaction with its natural and anthropogenic environment. Historical buildings and monuments are, nonetheless, “unique” compared to contemporary ordinary structures, in the sense that 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 2<sup>nd</sup> level thematic nodes.

Specifically, while envisioning a general timeline-type approach, the **archaeological study [A10]** is a typical thematic area relevant to the analysis of the CH asset. This thematic area regards archaeological excavations, archaeological surveys and conservation activities related to archaeological sites. For these 3<sup>rd</sup> level thematic areas, relevant use cases will be presented and appropriate educational material will be developed (Task 1.4 & Task 1.5). Similarly, the subject of archaeological surveys will be presented - with emphasis on Technology - and will conclude with presentation of use cases and educational material for conservation activities.

In a similar manner, **historical documentation [A20]** 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. Experience from undergraduate and postgraduate courses has revealed that students (and thus future scientists and professional) lack the appropriate training to conduct a comprehensive historical documentation as part of their course or scientific work. Instead, they are increasingly more dependent on more internet-based information, which is often of limited scientific value. This thematic node will provide the users with a concise opportunity to properly conduct a historical documentation.

An important part of the analysis of the CH asset is its **architectural analysis [A30]**. This can be approached in three main groups (3<sup>rd</sup> level TNs):

- (a) Historic cities
- (b) historic buildings and monuments
- (c) cross-cutting digital technologies for documentation and modelling.

**Historic cities** are complex and socially sensitive case studies that entail a wide variety of thematic issues, such as urban planning, design, operation and maintenance of city infrastructure, the socio-economic interaction between the city and its inhabitants their priorities and needs, the ever-changing legislation that governs the city’s functioning and development, and finally the interaction between the historic city and its natural or anthropogenic environment.

The **historic buildings and monuments** must be analyzed regarding their Architecture and construction technologies, supported by effective retrieval of information from relevant archives. The architectural documentation and analysis of architectural drawings is an important thematic area, useful for other engineering disciplines too, whereas the thematic area of constructional analysis and documentation, must be approached through the perspective of architecture. Obviously all these thematic areas are interlinked with other TNs, such as Diagnosis [A70] or Structural analysis – assessment [A80], which approach the same subject from other perspectives

**Geometric documentation [A40]** is another thematic node, with an intense IT content and will cover subjects (Table 1) such as passive and active methods of data acquisition, advanced processing of data and the latest advancements in the creation of geometric documentation products.





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The analysis of the CH asset cannot be comprehensive without understanding the role of **Materials [A50]**. 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 Cultural Heritage. In this framework, and of trans-cutting and interdisciplinary importance, the various 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 2<sup>nd</sup> level thematic nodes effectively largely focus on the CH asset itself. However, as in any ordinary structure or infrastructure, the **environment [A60]** is a crucial factor that influences the operation and state of the CH asset. Therefore, it is important to understand the various environmental loads acting upon the CH asset (Table 1). These include the atmospheric pollution, the water interaction (in the various forms that water interacts with the monuments and the environment), earthquakes, climate change and anthropogenic impact, all considered with regards to risk assessment and management and assessment of their impact on CH assets.

Supporting all these, an important technology-intensive 2<sup>nd</sup> level thematic node regards **diagnosis [A70]**. This refers to a methodological study of the decay and damage. Decay refers to the identification, classification and documentation of decay patterns, their mapping with non-destructive techniques (NDT), modeling of the decay and evaluation of the susceptibility of materials to decay factors. Similarly dealt, damage refers to identification of damage patterns (that can provide relevant crucial information to various engineering disciplines), its mapping by NDTs and of course identification and evaluation of their causes and mechanisms. Diagnosis provides the necessary information to assess the preservation state of the CH asset as well as to assess the environmental impact, both with a strong mapping and data-management character.

Similarly, the **analysis and assessment of the structural behavior [A80]** 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 [A90]**. This thematic issue, therefore, needs to be addressed, especially regarding 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 [A100]**. This is a critical component of advanced assessment campaigns, as exemplified by the experience from use case of the rehabilitation of the Holy Aedicule of the Holy Sepulchre, due to the need to fuse, manage and present large amounts of multi-spectral and multi-modal data. To some extent,



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this 2<sup>nd</sup> level thematic node reflects the emerging need for efficient state-of-the-art user-interface, with emphasis on 3-dimensional representations, virtual reality and augmented reality.

The second 1<sup>st</sup> level thematic node, that follows the assessment of the CH asset, regards all the issues relevant to **DECISION MAKING** (Table 1). Arguably, it is a poly-parametric process that involves many stakeholders in CH. It builds upon the knowledge gained from the previous 1<sup>st</sup> level thematic node and can be broken up into five general categories (2<sup>nd</sup> level thematic nodes). The first one regards all the relevant **studies [B10]** (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 [B20]**, to which any decisions must adhere to. Decision making, in contrast to most engineering and scientific disciplines, are subject to often contradicting legislations, and any decisions hold immense legal responsibilities.

An important 2<sup>nd</sup> level TN regards the various **categories of stakeholders [B30]**: Ministries and national bodies, regional and local authorities, society – wide public, religion stakeholders, private entities and persons, NGOs, and of course the scientific and technical communities, all of which create a complex matrix of responsibilities and interest. Moreover, the **socio-economic and technical framework [B40]** 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 will discuss how CH is protected in areas of **conflicts and how cooperation challenges [B50]** with relevant authorities and stakeholders can be addressed.

The third 1<sup>st</sup> level TN compiles and describes all the necessary steps for implementing any **INTERVENTIONS** required and decided upon from the two aforementioned 1<sup>st</sup> level thematic nodes. The initial stage of such a comprehensive array of task regards, obviously, the **design of interventions [C10]**. This 2<sup>nd</sup> 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 [C20]** of such projects is discussed, since these are thematic subjects not often well understood, despite their importance. Similarly, **risk management and contingency planning [C30]** 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 [C40]**. 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.

The following thematic area regards the main issues related to the **implementation of interventions [C50]**. Obviously, with such a large variety of CH use cases, and with a multitude of possibilities, 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. In this framework 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 [C60]**, 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



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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 [C70]**. New findings are revealed and documented during the implementation of works, or during parallel or post-works analysis of new data. These findings 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. But equally important, communication strategies must be adopted to effectively disseminate such findings to the media and to the Society or present them in exhibitions

Finally, the fourth 1<sup>st</sup> level thematic node regards the important issue of **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 [D10]**, where critical parameters are set and monitored, through permanent sensors and instrumentation or through regular scientific surveys. Similarly, **monitoring of the environment [D20]** 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 [D30]** that includes preventive and regular maintenance schemes, prioritization procedures and interaction with the Society. In an analogous approach, **environmental management [D40]** 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 [D50]** 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 [D60]**. 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 Cultural Heritage, Education can emerge as the fusion tool for all this knowledge.

In this framework, the development of the EDICULA thematic nodes tracks both the regular flow of activities in CH protection, but also expands into the typical and most important issues encountered by the scientific and technical communities.



Table 1. Thematic nodes of the EDICUCA Educational Toolkits

## [A] ANALYSIS OF CH ASSET

### [A10] ARCHAEOLOGICAL STUDY

#### 11 Archaeological excavations

- 11A Research excavations
- 11B Rescue excavations
- 11C Archaeometry
- 11D Archaeogene
- 11E Archaeobotany
- 11F Archaeozoology
- 11G Paleopathology

#### 12 Archaeological Surveys

- 12A Field surveys
- 12B Aerial archaeology
- 12C Geophysical surveys
- 12D Landscape archaeology
- 12E Settlement archaeology
- 12F Maritime archaeology
- 12G Cognitive archaeology

#### 13 Conservation activities

- 13A Conservation ethics
- 13B General techniques of conservation
- 13C Field conservation
- 13D Laboratory conservation

### [A20] HISTORICAL DOCUMENTATION

#### 21 Archives

- 21A Ancient texts
- 21B Ancient inscriptions
- 22C Numismatics

#### 22 Libraries

- 22A Digital libraries – Scientific publications

#### 23 Information Technology

- 23A IoT

### [A30] ARCHITECTURAL ANALYSIS

#### 31 Historic Cities

- 31A Retrieval of information from archives
- 31B Urban planning, documentation, and analysis
- 31C Infrastructure of Historic City
- 31D Socio-economic trends and needs
- 31E Legislation
- 31F Historic city and surrounding Landscape

#### 32 Architecture of historic buildings and monuments

- 32A Architecture and construction of historic buildings and monuments
- 32B Retrieval of information from archives
- 32C Architectural documentation and analysis of architectural drawings



- 32D Constructional analysis and documentation
- 32E Damages, cracks, humidity and other problems

### 33 Digital technologies: Documentation and modelling

- 33A Virtual models and augmented reality

## [A40] GEOMETRIC DOCUMENTATION

### 41 Introduction to the necessity of Geometric Documentation (GD)

### 42 Definitions – Possible products of GD

- 42A Complexity
- 42B Quality
- 42C HBIM

### 43 Methods of data acquisition for the GD

- 43A Passive methods
  - 43A1 *Surveying (topographic measurements, GNSS)*
  - 43A2 *Photogrammetry (satellite, aerial, UAV, terrestrial, underwater)*
  - 43A3 *Remote Sensing (hyperspectral imaging, thermal cameras)*
- 43B Active methods
  - 43B1 *Laser scanning (LiDAR, TLS)*
  - 43B2 *Other forms of scanning*
  - 43B3 *Range based methods*

### 44 Processing of acquired data

- 44A Point clouds
- 44B Automation
- 44C GIS

### 45 Geometric Documentation products

- 45A Vector drawings (2D)
- 45B Raster drawings (2D)
- 45C 3D models
- 45D Mixed realities
- 45E Serious Games

## [A50] MATERIALS

### 51 Building materials

- 51A Historic building materials
  - 51A1 *Natural stones*
  - 51A2 *Mortars and binders*
  - 51A3 *Bricks and ceramics*
  - 51A4 *Plasters*
- 51B Characterization of materials properties
  - 51B1 *In-situ non-destructive characterization and mapping*
  - 51B2 *Laboratory testing (instrumental and physical methods)*
- 51C Production technology and provenance

### 52 Decorative materials

- 52A Wall paintings
- 52B Mosaics

### 53 Decay products from the impact of environment

- 53A Crusts and depositions
- 53B Salt Efflorescences
- 53C Cracks
- 53D Delamination and detachment of materials



53E Biological decay products

## 54 Restoration materials

54A Replacement stones and artificial stones

54B Restoration mortars

54C Restoration bricks and ceramics

54D Metal and strengthening elements

54E Restoration plasters

## 55 Consolidation and strengthening materials and techniques

55A Pre-consolidation and consolidation materials and techniques

55B Grouts

55C Strengthening materials and techniques

## 56 Conservation and protection materials and techniques

56A Cleaning of surfaces

56B Conservation of wall paintings and mosaics

56C Conservation of decorative elements

56B Protection materials and techniques

## 57 Smart and advanced materials and techniques

## 58 Non-destructive testing for assessment & evaluation of materials and interventions

58A Non-destructive assessment of mechanical properties

58A1 *Pulse-echo ultrasonic testing for assessment of mechanical properties*

58A2 *Rebound testing – Schmidt Hammer*

58B Microstructure analysis

58B1 *Portable video microscopy – Fibre Optics Microscopy*

58B2 *X-Ray Fluorescence*

58B3 *Laser-induced breakdown spectroscopy*

58C Surface or near surface analysis

58C1 *Infra-red thermography*

58C2 *Portable video microscopy – Fibre Optics Microscopy*

58C3 *Pulse-echo ultrasonic tomography and testing for assessment of damage layers*

58D Geophysical methods

58D1 *Ground penetrating radar*

58D2 *Electric resistance tomography*

58E Prospection technologies

58E1 *Remote-control probing robots*

58E2 *Endoscopy*

58F Mapping of materials on surfaces and structures

58F1 *Digital image processing*

58F2 *Materials data management and GIS*

## [A60] ENVIRONMENT

### 61 Atmospheric pollution

61A CH assets in urban environment

61A1 *Primary and secondary pollutants*

61A2 *Aerosols*

61B Historic Cities

61B1 *Migration of air pollution*





## 62 Water interaction

- 62A Atmospheric precipitation
  - 62A1 *Acid rain*
  - 62A2 *Aerosols*
- 62B Rising damp
- 62C CH assets in marine environment
- 62D Salt crystallization
- 62E Freeze-Thaw damage to building materials
- 62F Bio-damage of Cultural Heritage

## 63 Earthquakes

- 63A Earthquake risk
- 63B Geotechnical issues
- 63C Earthquakes at Historic Cities

## 64 Climate Change

- 64A Floods
- 64B Impact of extreme weather phenomena on CH

## 65 Anthropogenic impact

- 65A Historic Cities
  - 65A1 *Economic and social activities in Historic Cities*
  - 65A2 *Impact of CH from Historic City development*
- 65B Archaeological sites
  - 65B1 *Impact from visitors*
  - 65B2 *Archaeological sites in urban environment*
- 65C Historic buildings and monuments
  - 65C1 *Historic buildings in use*
  - 65C2 *Historic buildings as museums*
- 65D Tourism

## 66 Risk assessment and management

- 66A Identification and assessment of risks
- 66B Risk prioritization
- 66C Risk reduction measures
- 66D Resilience of CH

## 67 Environmental Impact Assessment

- 67A Field visits
- 67B Environmental impact assessment reports

## [A70] DIAGNOSIS

### 71 Methodology of Diagnosis

#### 72 Decay

- 72A Decay patterns
- 72B Decay mapping by NDT
- 72C Decay mechanisms
- 72D Modeling of decay
- 72E Susceptibility of materials to decay

#### 73 Damage

- 73A Damage patterns
- 73B Damage mapping by NDT
- 73C Causes & mechanisms



## 74 Preservation State

- 74A Synthesis of decay and damage to the pathology analysis for the characterization of the preservation state
- 74B Classification of the preservation state

## 75 Environmental Impact Assessment

- 75A Mapping of environmental stresses
- 75B Mapping of environmental impact
- 75C GIS management of environmental impact assessment data
- 75D Stochastic analysis correlating environmental stresses to environmental impact

## [A80] STRUCTURAL ANALYSIS – ASSESSMENT

### 81 Analytical structural and assessment methods

- 81A Laboratory testing
- 81B Structural assessment

### 82 Structural Health Monitoring

- 82A Field testing
- 82B Vibrations measurements in situ

### 83 Numerical approximation methods for structural integrity

- 83A Finite Element Modelling

### 84 Earthquake Engineering

- 84A Assessment of seismic performance
- 84B Experimental assessment / Shake-Table testing

## [A90] VALORIZATION-VALUES

### 91 Importance of the CH asset

- 91A Values of the CH asset
- 91B Interaction with the Society

### 92 Authenticity

- 92A Modifications & past intervention of the CH asset
- 92B Authenticity of the CH asset's elements

### 93 Compatibility of past interventions with the original CH asset

## [A100] Knowledge-based Digital Infrastructure

### 101 Fusion of multidisciplinary data

- 101A Correlation of multi-spectral / multi-modal data
- 101B Semantic data integration

### 102 Multilayer management of big data

- 102A Holistic Ontology-based assets records

### 103 Information platforms

- 103A Time-dynamic 3D reconstruction of CH assets
- 103B Heritage – Building Information Models (HBIM)
- 103C Geographical Information Systems (GIS)

### 104 Virtual Reality / Augmented Reality

### 105 Artificial Intelligence and Machine Learning



## [B] DECISION MAKING

### [B10] STUDIES

- 11 Architectural Study
- 12 Structural Study
- 13 Materials and Interventions Study
- 14 Other studies

### [B20] LEGISLATION FRAMEWORK

- 21 Adherence to international and national legislation
- 22 Legal responsibility of CH managers / CH works

### [B30] STAKEHOLDERS

- 31 CH Governance at national level
- 32 Regional and local stakeholders
- 33 Society – Wide public
- 34 Religion
- 35 Private stakeholder & NGOs
- 36 Scientific Communities
- 37 Technical Communities
- 38 Cross-responsibility issues among stakeholders

### [B40] SOCIO-ECONOMIC & TECHNICAL FRAMEWORK

- 41 Perception of CH by Society
- 42 Interaction and interrelation of Tourism and CH
- 43 Impact of CH on the development of Historic Cities
- 44 Financing CH Protection
  - 44A Governmental funding
  - 44B European and International Research Funding
  - 44C Private funding
  - 44D Self-financing of CH
- 45 Research at the level of Universities
  - 45A Innovation
  - 45B Centers of Excellence – Research infrastructure
  - 45C Cooperation of Universities with Industry and SMEs
- 46 Research at the level of Ministries and relevant authorities
- 47 The role of Construction industry
- 48 Limitations of implementing CH-related works within confined environments
  - 48A Archaeological sites in urban environment
  - 48B Disruption of socio-economic life

### [B50] Conflicts and Challenges

- 51 Protection of CH in areas of conflicts
- 52 Cooperation challenges with relevant authorities and stakeholders



## [C] INTERVENTIONS

### [C10] DESIGN OF INTERVENTIONS

#### 11 Organization of worksite

#### 12 Organization of in-situ laboratories and workshops

#### 13 Logistics of materials and equipment

- 12A Calculation of quantities of materials and equipment
- 12B Ordering and delivering materials and equipment
- 12C Design and construction of special equipment
- 12D Storage and handling of materials and equipment
- 12E Cooperation with suppliers and relevant authorities

#### 14 Human resources issues

- 14A Selection and employment of personnel
- 14B Travel, Food, Accommodation and Health Insurance

#### 15 Design of the iterative process of the main stages

- 15A Gantt-charts and pre-planning of stages
- 15B Definition of targets and objectives per stage

#### 16 Description of interventions

- 16A Detailed specifications for materials, procedures and techniques
- 16B Creation of detail drawings

### [C20] INTEGRATED GOVERNANCE

#### 21 Integrated governance of the project

#### 22 Monitoring, quality control, assessment and evaluation

#### 22 Scientific support to decision making

### [C30] RISK MANAGEMENT & CONTINGENCY PLAN

#### 31 Identification of potential risks

#### 32 Procedures for risk management

#### 33 Safety issues

### [C40] PILOT-SCALE WORKS

#### 41 Design of pilot-scale works

#### 42 Selection of characteristic areas

#### 43 Implementation of pilot-scale works

#### 44 Assessment of data from pilot-scale works

#### 45 Comparative evaluations between alternative approaches

#### 46 Optimization of interventions

### [C50] IMPLEMENTATION OF INTERVENTIONS

#### 51 Implementation of interventions

- 51A Interventions aiming to assure structural integrity
- 61B Interventions aiming to reveal and preserve the values
- 51C Interventions aiming to enhance the sustainability of the CH asset

#### 52 Documentation of works

- 52A Digital depositories

### [C60] ASSESSMENT & EVALUATION OF INTERVENTIONS

#### 61 Criteria for assessment and evaluation

- 61A Compatibility



- 61B Performance
- 61C Architectural authenticity
- 61D Structural integrity

**62 In-situ validation by advanced NDTs and conventional testing**

**63 Validation of the response of the retrofitted structure by modelling**

## **[C70] REVEALING AND PRESERVATION OF VALUES**

### **71 Revealing of new findings**

- 71A Revealing of new findings during the implementation of works
- 71B Revealing of new findings through analysis of new data
  - 71B1 *Archaeological approach*
  - 71B2 *Archaeometric approach*
  - 71B3 *Archaeogene approach*
  - 71B4 *Evolution of construction phases*
  - 71B5 *Architectural approach*

### **72 Optimization of interventions to ensure preservation of values**

- 72A Risk analysis for the preservation of values
- 72B Design, implementation and documentation of relevant mitigation & protection measures

### **73 Communication strategies**

- 73A Dissemination to the media and to the Society
- 73B Exhibitions

## **[D] SUSTAINABILITY**

### **[D10] MONITORING OF CH ASSET**

- 11 Definition of critical monitoring parameters and monitoring protocols**
- 12 Monitoring of CH assets through permanent sensors and instrumentation**
- 13 Monitoring of CH assets through regular scientific surveys**

### **[D20] MONITORING OF THE ENVIRONMENT**

- 21 Definition of critical monitoring parameters and monitoring protocols**
- 22 Monitoring of environmental parameters through permanent sensors and instrumentation at the CH asset**
- 23 Monitoring of environmental parameters through regular scientific surveys**
- 24 Monitoring of data from environmental databases**

### **[D30] STRATEGIC PLANNING**

- 31 Preventive and regular maintenance schemes**
- 32 Prioritization of risks and needs**
- 33 Interaction with Society**

### **[D40] ENVIRONMENTAL MANAGEMENT**

- 41 Historic cities**
  - 41A Interventions to the surroundings of the historic city at local or regional level
  - 41B Interventions to infrastructure of the historic city
- 42 Archaeological sites**
  - 42A Interventions to the urban environment around archaeological sites
  - 42B Cultural routes
- 43 Historic buildings and monuments**
  - 43A Interventions to the urban environment



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## **[D50] DISSEMINATION, COMMUNICATION AND INTERACTION WITH THE SOCIETY**

**51 Dissemination**

**52 Communication**

**53 Dialogue between Science, Authorities and the Society**

**54 Integration of the CH asset into the socio-economic development**

**55 Tourism**

## **[D60] EDUCATION**

**61 Cultural Heritage Related Educational Programs at Universities**

61A Post-graduate programs

61B Undergraduate programs

61C Employability by authorities and stakeholders

**62 Training of the technical community**

**63 Educating the general public**





#### 4. The generic core and the thematic nodes

The architecture of the two EDICULA toolboxes, the 4-all toolbox and the PLUS toolbox 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. The thematic components have been described in the previous section. A critical step in the definition of the architecture, thus, is to define the components’ features, using certain rules.

As described in more detail in the previous section, an overview of 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. Their interdependence is shown in the following figure.

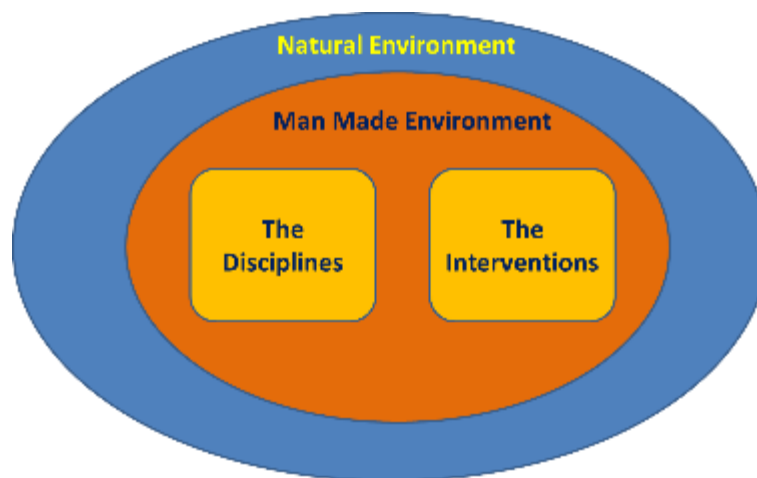


Figure 2. Thematic components overview.

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.

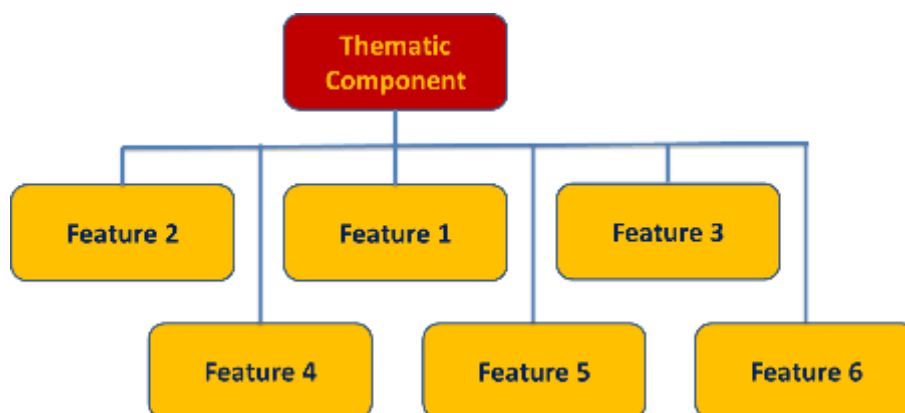


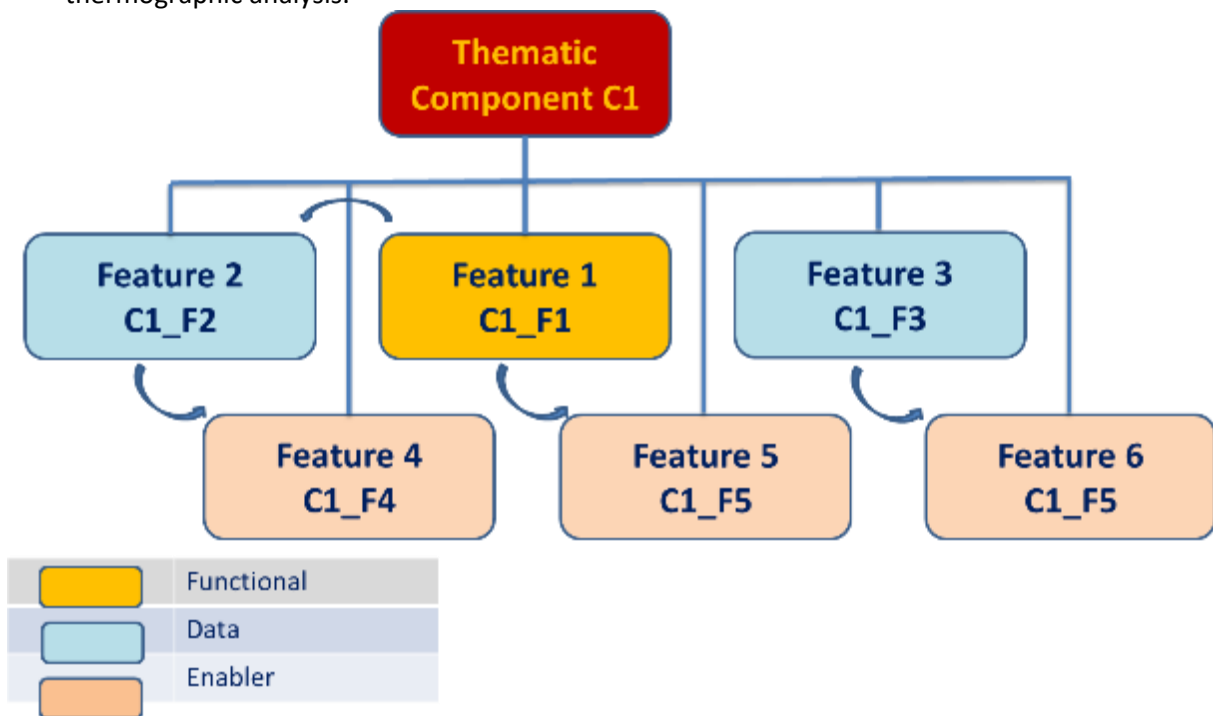
Figure 3. The features of a typical thematic component



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 thematic 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.



Feature	Link	Comment
C1_F1	C1_F5	Feature C1_F1 is functional and is “enabled by feature C1_F5.
C1_F1	C1_F2	Feature C1_F1 is functional, and its dynamic data are managed by feature C1_F2.
C1_F2	C1_F4	Feature C1_F2 is data and is “enabled by feature C1_F4.
C1_F3	C1_F6	Feature C1_F3 is static component C1 data and is “enabled by feature C1_F6.

Figure 4. The relationship between thematic components and functional, data and enabler features



## 4.1 Functional features

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.

## 4.2 Data features

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.

## 4.3 Enabler features

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.

## 4.4 Project cores

Each project core is a mutation of the generic core and comprises project components and project features. As an example, component C1 once inserted in the domain of project P1, becomes C1\_P1. Feature C1\_F1 once inserted in the domain of project P1, becomes C1\_F1\_P1 (see Figure 5). This approach enables the rapid generation of project cores from the generic core. An example of a project core is the project of the rehabilitation of the Holy Aedicule of the Holy Sepulchre, which will function as a prime educational use case.

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. Three or more of iterations should be expected (Figure 6).

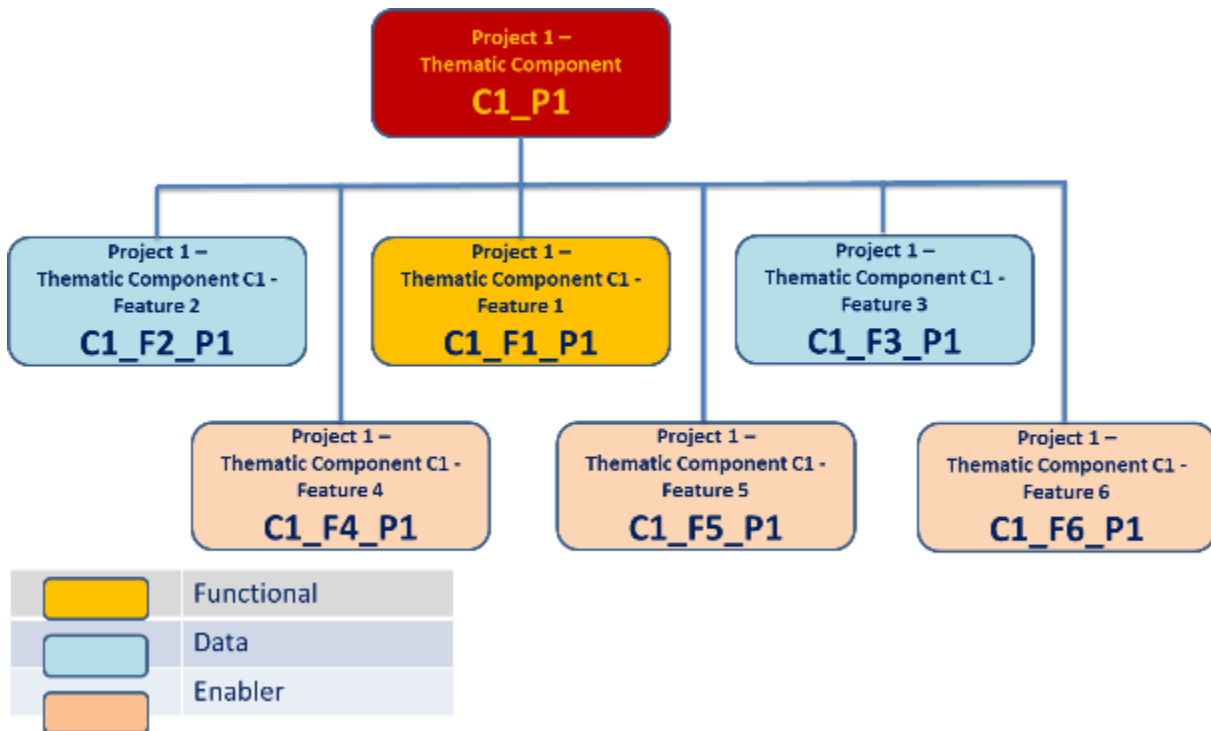


Figure 5. Project 1 – Thematic Component C1

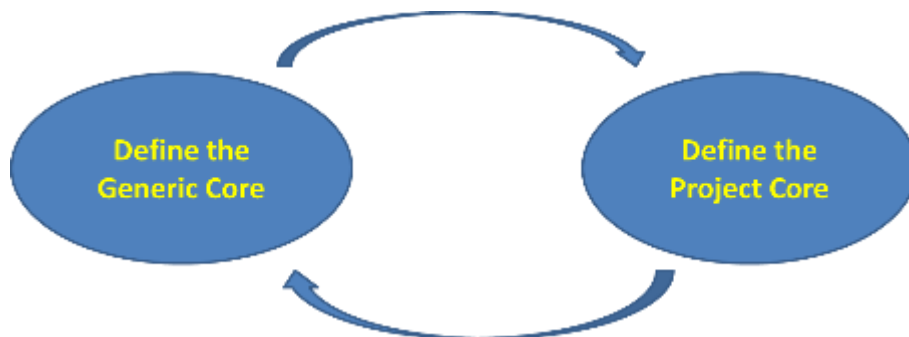


Figure 6. Feedback loop: Generic core and project domain

## 5. The effect of users’ requirements on the architecture of the toolkits

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.



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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 must take 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 “bombardment” 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. Within this framework, the following users groups have been defined

## 5.1 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. For example, a citizen with a basic-level educational background who is interested in the subject of CH protection may have different expectations from the EDICULA-4-all educational toolkit, compared to an educated citizen (e.g. university level background) that is interested in the same subject but from the perspective of Tourism (e.g. a merchant that wants to explore potential development opportunities for their business in a historic city, or citizens that simply want to better understand the conservation activities they encounter when they visit a CH site):

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 EDICULA-4-all educational toolkit will allow the general public to develop new participatory and intercultural approaches to the protection of monuments, as well as educational initiatives aimed at fostering intercultural dialogue. Within this context the following sub-groups can be defined:

### 5.1.1 Active citizens with basic interest in CH protection

Users in this sub-group require basic information, with easy-to-understand terminology and user-friendly platform-user interfaces that will allow them to “navigate” through the various thematic areas of the complex field of CH protection. Specific case-studies, such as the rehabilitation of the Holy Aedicule of the Holy Sepulchre, can allow them to relate their own experiences with CH. Tourism is a typical catalyst for an interest in CH, since citizens that travel and visit CH assets often develop a need to learn more and better understand the site or monument they visited. Social development is another driving force for an interest



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in CH protection, with active citizens realizing that CH is a fundamental element of our Society that needs to be protected appropriately and effectively.

## **5.1.2 Citizens with economic interest in CH protection**

Users in this sub-group include all those citizens who have an interest in CH protection and want to utilize the EDICULA-4-all educational toolkit in order to become more acquainted with the issues related to CH protection from the perspective of business or economic opportunities. This is also a wide sub-group that includes many professionals not directly related to CH protection, but who would like to benefit from understanding how CH is protected. An obvious such group of citizens includes merchants and professionals (e.g. hotel operators, itinerary service providers, travel agents, tourist shops, restaurant / café operators, artists etc.) that want to better understand the basic issues in CH protection in order to improve the services they provide, their own infrastructure (e.g. restoration of their historic buildings) or explore new business opportunities. Tourism is a strong driving force in this sub-group too, but from the perspective of economic development, although other driving forces such as business diversity and business expansion opportunities often play a similar role.

Citizens of this sub-group can indirectly (or directly in some cases) be involved in decision making processes, relevant to the protection of CH. For example, as citizens and professionals in a historic City are getting more involved socially for the protection of their own city, even due to economic interests, local and regional authorities must start taking into account their needs and requests. Therefore, although not directly involved in the actual decision making processes themselves, or categorized as “stakeholders” (see relevant group), the fact that these citizens and professionals start “asking” the right questions and press the relevant authorities for appropriate actions is a beneficial outcome and educational need that the EDICULA-4-all is called upon to fulfil.

## **5.2 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. The EDICULA project includes also other training activities, for specific student categories, but the EDICULA toolkits should be designed such that they address the evolving educational needs of students. The terminology needs to be gradually more complex, relating to the educational level of the students. This may require preparation and uploading to the platform of additional “simplified” educational material for users not acquainted with specific terminology.

It should be realized that students consist a very specific group of users that will form the future Experts and Professionals in various fields and especially in the field of Cultural Heritage Protection. The importance of this field is crucial and there is a need of importing innovative practices in the academic training with an intentional focusing on digital methods. Interdisciplinarity is also an important virtue that students should develop in order to ensure a common language of communication for their future professional skills.

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.





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The Youth today is very familiar with IT, especially AR, often much more compared to the general public. The EDICULA-4-all educational toolkit needs therefore to exploit this “skill” of the students focusing on media more familiar to the students, such as videos, AR or VR applications, or narrative-type diffusion of information. In comparison, older people from the general public may prefer reading-type presentation of information. In conjunction with the benefits of the social-media and the ease and abundance of information through internet, European students have formed an extensive intercultural connection in terms of social manner. Therefore it is important that training, learning and applying techniques should be formed also at an intercultural level through their education. Summer schools, academic curricula accessible digitally through the toolkit can serve as tools for such advancement forming awareness among students for the European cultural heritage identity and also for their skills development.

### 5.3 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”. The protection of CH and the values it carries is usually an important responsibility of the central government or local and regional authorities. In most countries, 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. Adding to this rather complex and ineffective situation is the fact that many of these 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.

The EDICULA+ and to a lesser extent the EDICULA-4-all educational toolkits should have an architecture such that it can address the needs of these stakeholders. Due to their varying level of skills, educational and scientific backgrounds, as well as the varying needs of members of this group, the toolkits should be characterized by a dynamic flexibility, in the sense of providing the necessary information with the most appropriate user-optimized level of analysis. In effect, the thematic nodes described in a previous section should all be available to users of this group, however “activated” as required and with the appropriate array of information. Terminology is not an important issue as in the case of the general public or students, since experts and professionals in this group have the capacity to understand or learn it rather quickly. If necessary, for example when a member of a CH stakeholder is not familiar with this terminology or cannot fully understand it, he or she may first use the EDICULA-4-all toolkit before resorting to the more analytical EDICULA+.

The main differentiation between experts and professionals in CH-related stakeholders and the aforementioned sub-group of “*citizens with economic interest in CH protection*” is the more active role the former have in decision making processes. For example, an engineer from a Prefecture or a Municipality Authority that he or she is responsible for creating or approving a development plan for a historic city is more involved in the overall decision-making process compared to a construction engineer that he or she are interested in participating in restoration projects. Their educational needs, thus, may be completely different in terms of applications, levels of analysis and general guidelines. It is expected that experts and professionals more actively involved in decision making processes are required to have a more overall knowledge, critical thinking and synthesis of all issues related to CH protection. In this framework, the educational benefits of the EDICULA toolkits are indispensable.



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## 5.4 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. For example the STEM expertise of a high-school teacher is not necessarily required to be as analytical or advanced as the experience and know-how of a University professor. However, the same is valid for the respective students.

The terminology and the educational content of the toolkits need to be adjusted accordingly. For example, if an elementary teacher that teaches history would like to utilize the toolkits to provide a different insight to his or her students regarding the importance of preserving our Cultural Heritage, then, the available educational material should be adjusted or presented accordingly, focusing on issues more relevant to the subject taught.

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. However, the wider availability and accessibility of the EDICULA toolkits enables them to support such a transformational process for other courses. Indeed, the architecture of the toolkits is such that it "triggers" University professors to approach the courses they offer from a similar interdisciplinary/transdisciplinary approach, highlighting the need to find "solutions" through an overall process involving many parameters; an experience relevant to many scientific fields.

Although the elementary- and high school teachers may have less flexibility in altering the content of the courses they teach (as typically this is to a large degree defined by guidelines from the central educational authorities), they can still benefit from the issues described in the toolkits, the way they are presented (with emphasis on digital methods and IT fusion of information) and the synthetic approach in problem-solving, so that they can transfer all these to their students.

## 5.5 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 (see relevant group of users). 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, which brings together expertise from a variety of relevant scientific fields. Even more important, the



scientific dialogue, as expressed by the Case Studies included 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 evolutionary.

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.

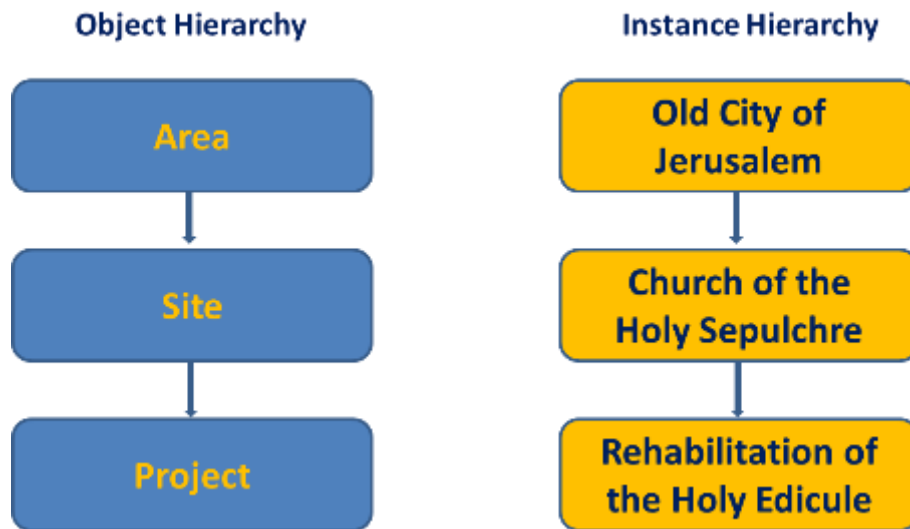
These projects are characterized by a strong “interventions” character, although it is the role of the Educational Toolkits to highlight the processes required prior- and post- interventions that ensure an effective and sustainable solution to the issues involved.

In 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.

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”



**Figure 7.** Transformation of Object Hierarchy into Instance Hierarchy

Therefore, when the project of the rehabilitation of the Holy Aedicule is utilized in a thematic node, e.g. C. Interventions (see Table 1), the hierarchy is transformed accordingly from a Logical Hierarchy into a Presentation Hierarchy (Figure 8):

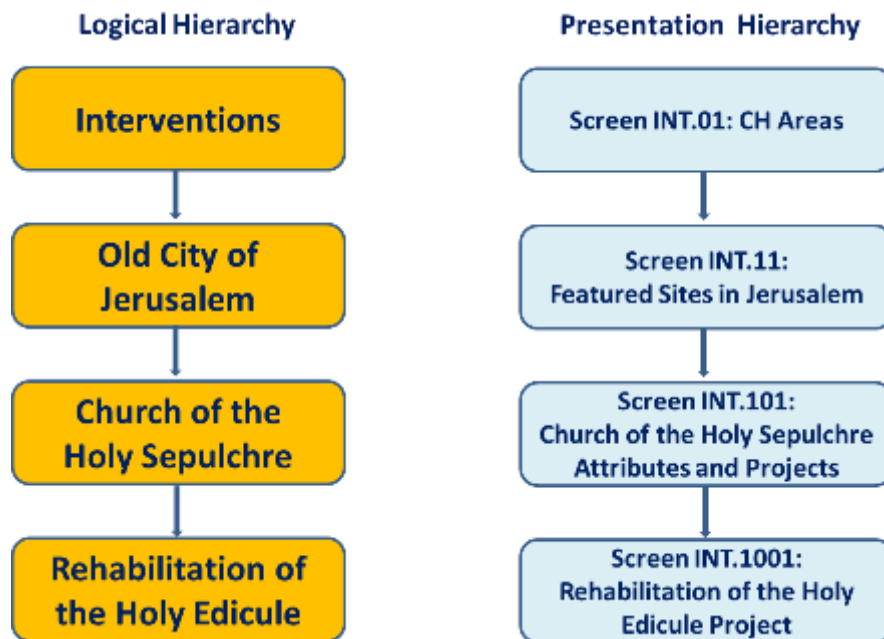


Figure 8. Transformation of Logical Hierarchy into Presentation Hierarchy

In this example of presentation hierarchy, at the introductory CH areas screen INT.01, there will be included two more general CH areas: a) The Old City and in the hinterland of Jerusalem (e.g., see Figure 9) and b) the City of Alexandria, Egypt.

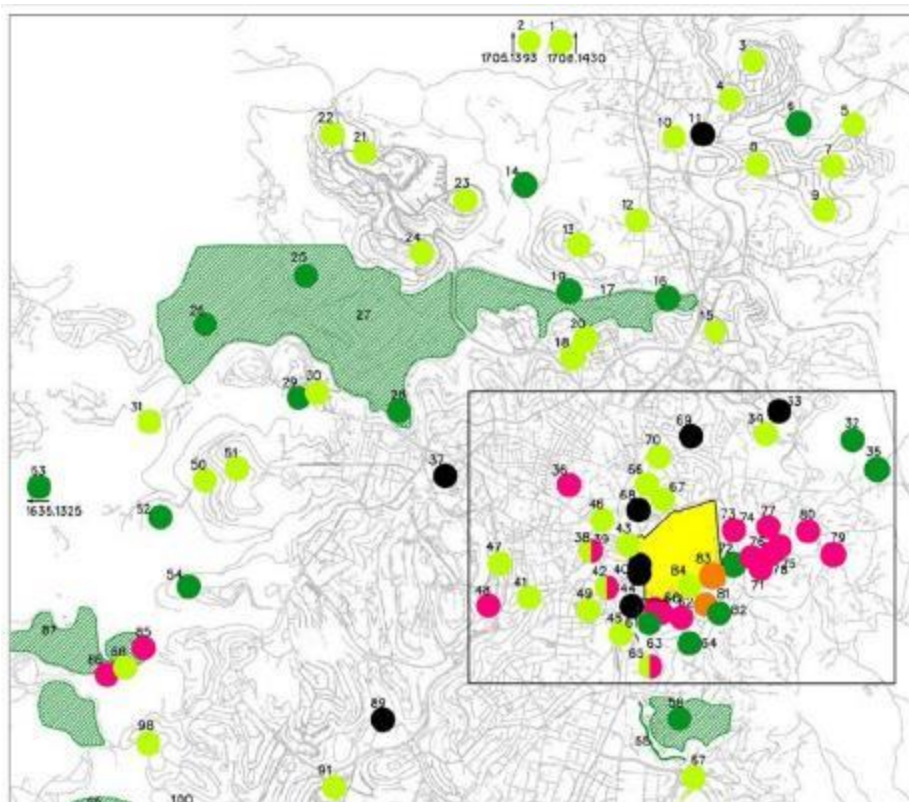


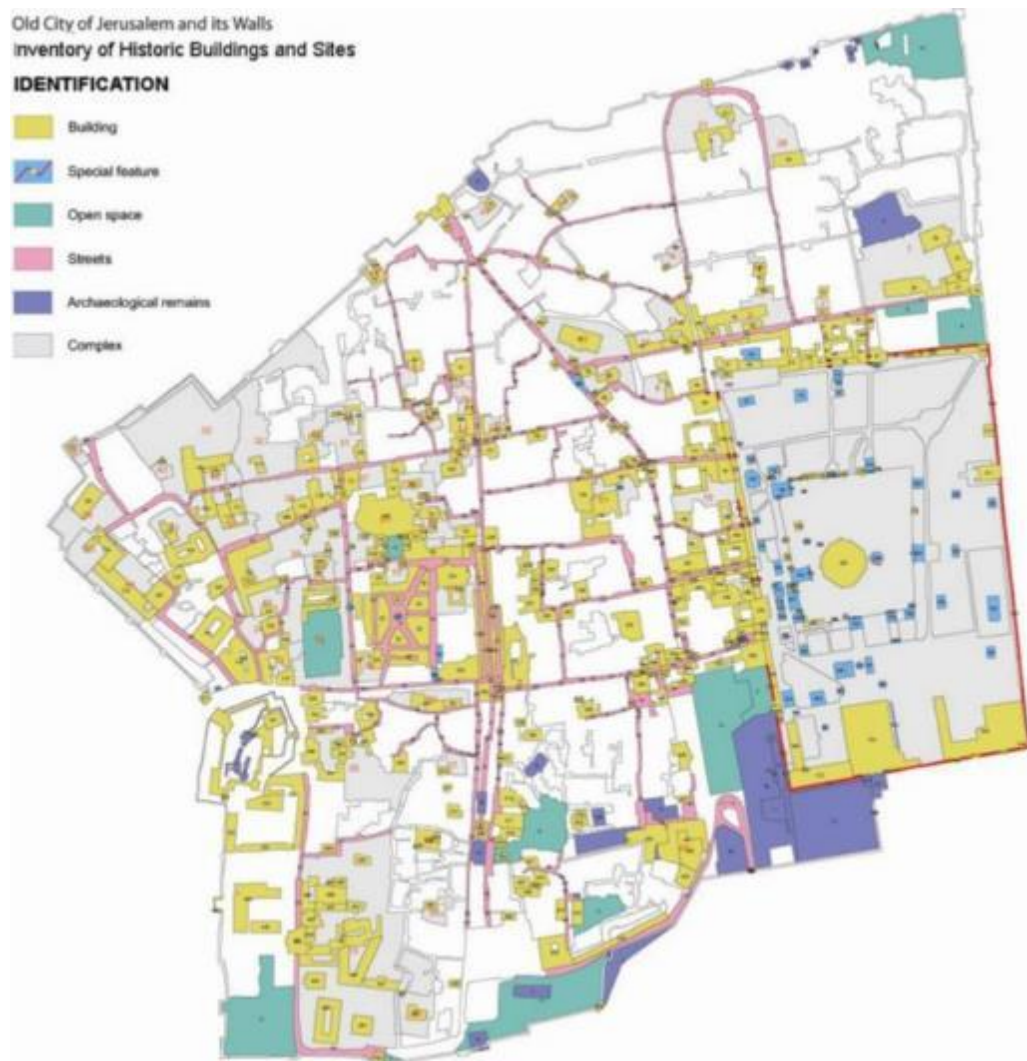
Figure 9. Selected sites around the Old City and in the hinterland of Jerusalem. Source: Israel Antiquities Authority, : <http://www.antiquities.org.il/InfoArchiologyList.aspx>





At the next level of hierarchy will be presented two groups of featured sites at the Old City of Jerusalem (INT.11 see Figure 10) and Ancient Alexandria (INT.12 see Figure 11). As more areas are added to the toolkit, they will be included in the interventions root menu. O

In the case of the Old City of Jerusalem, for example, the user can position the mouse over a site of interest and see the name and information about a site. In addition to the mouse sensitive map, the system can display a list of the sites. The use of maps in the toolkit may be extensive. As such, it will be supported by a Geographic Information System (GIS) (enabler feature).



**Figure 10.** Old City of Jerusalem and its Walls: UNESCO inventory of historic buildings and sites. Source: From the UNESCO Action Plan for Jerusalem 2006-2008





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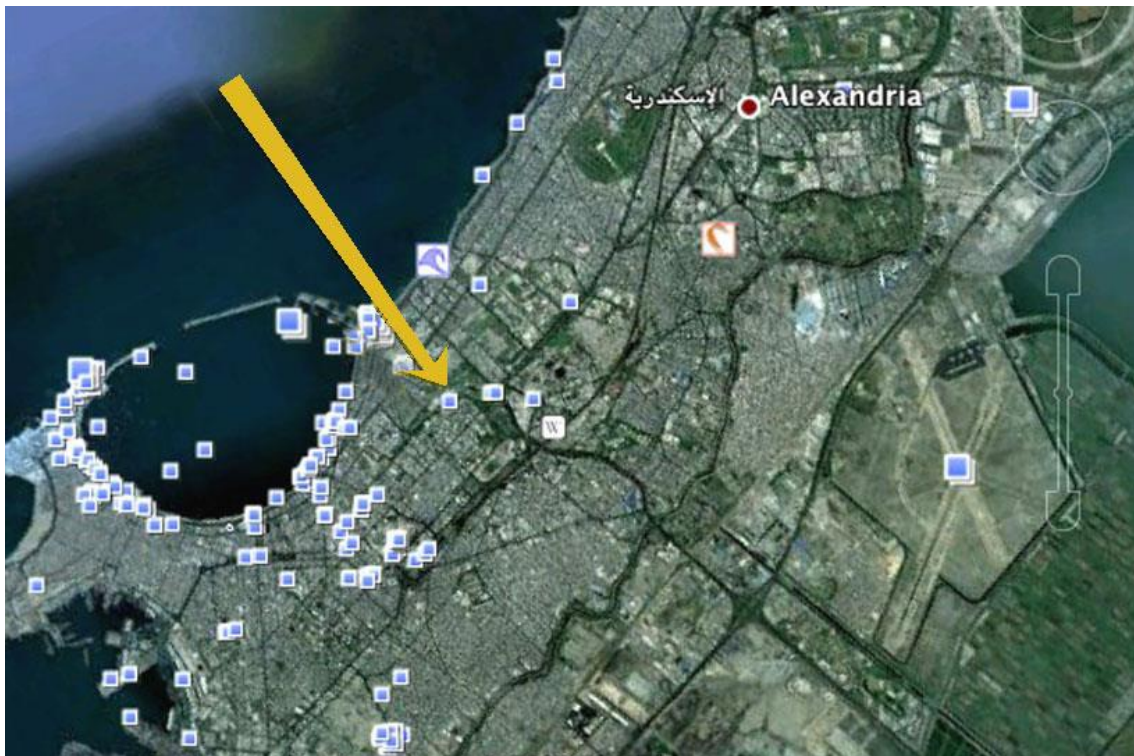
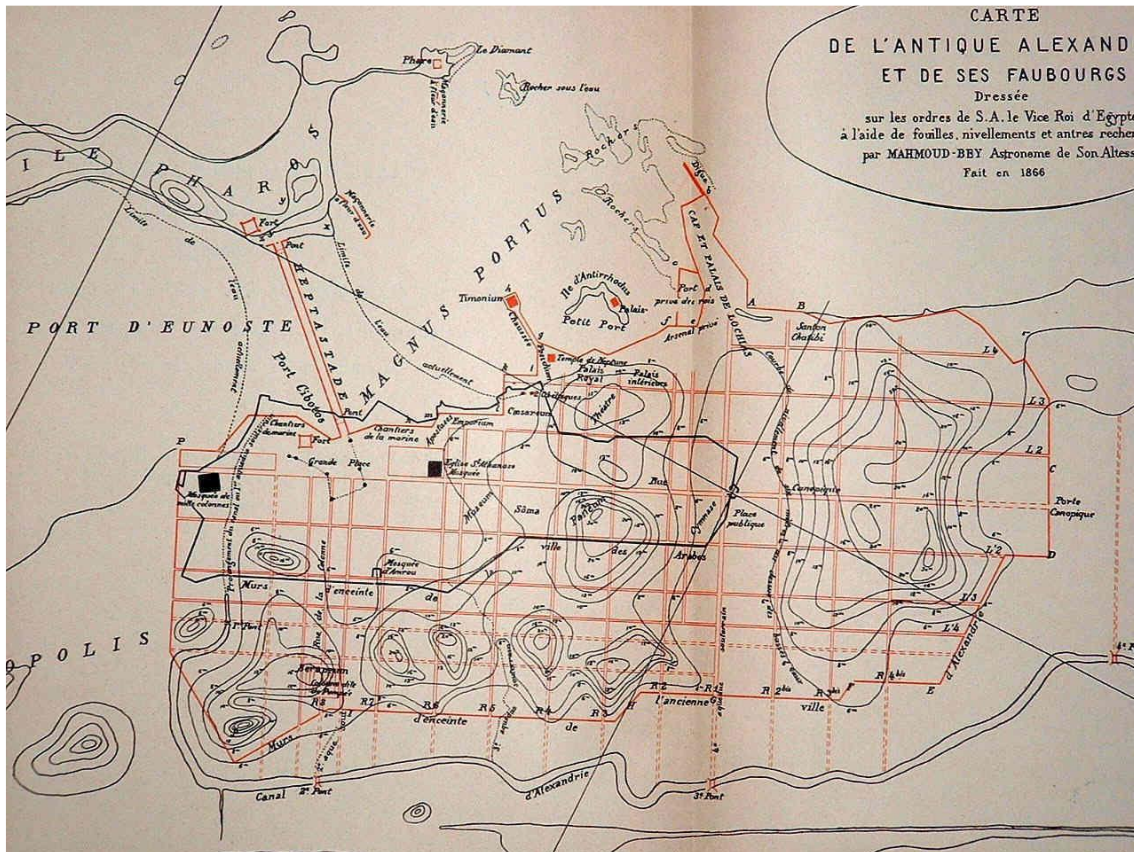


Figure 11. Map of ancient Ptolemaic Alexandria and current location of the archaeological survey at Shallalat Gardens of Alexandria





The form contains the following data tables:

Id object	Period
22	Crusader
22	Late Ottoman
22	

Id object	Elements	Condition
22	Stone - works	Ordinary
22	Iron - works	Ordinary
22	Doors - Windows	Bad
22		

Id object	Functions
22	Religion
22	

Figure 12. Example of a survey sheet from UNESCO action plan for Jerusalem 2006-2008

## 7. Technical requirements

### 7.1 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 courses as they originally intended and not have to make any major alterations in order to upload it into the platform. 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 courses content, forums for discussion, quizzes and multiple choice and content submission for assignments and other tasks.

The courses needed to be able to allow different user groups. This meant that 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 (Figure 16 & Figure 21).

## 7.2 Learning Analytics

Another main objective of the EDICULA-4-all e-learning platform is the recording and visualization 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 evaluation of the platform as a whole.

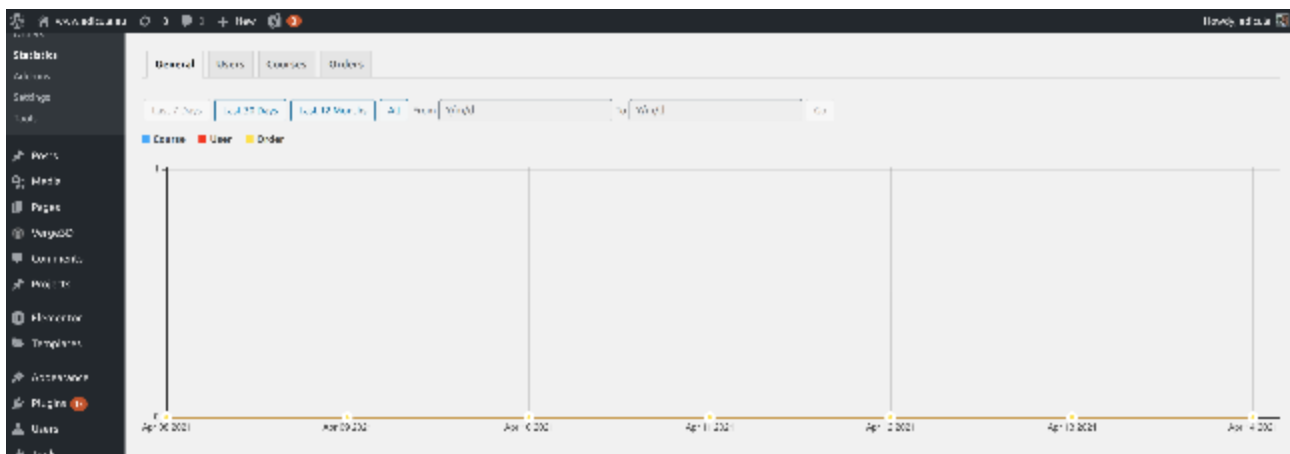


Figure 13. Learning analytics of the platform

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 needed to be used in order to record a whole range of data from the different activities and courses found within the educational platform.

## 7.3 Functional & non- functional requirements

EDICULA beneficiaries take into consideration the functional and non-functional requirements of the EDICULA educational toolkit (see Table 2). These requirements describe the main functionalities that should be addressed during the lifecycle of the project.



**Table 2.** Functional and non-functional requirements

Functional requirements	Non-functional requirements
1) Login screen	1) Multidisciplinary content
2) User registration form	3) Multimodal data
3) Search bar	4) Content management (store and retrieval)
4) Multiple choice interface	5) Suggest difficulty level
5) Account activation	6) Suggest educational program
6) Role allocation	7) Store and display statistic records
7) Follow tutor	8) Delete Account
8) Visualization of 3D data	9) Return to resubmit quizzes and courses

## 7.4 Hardware Requirements

The portal that will be developed for EDICULA is proposed to operate under the following hardware requirements to ensure compatibility with the proposed software, good performance, capacity, availability and latency, good security features, as well as maintainability and portability. Our educational platform is on-line available:

This hardware must be able to run flawlessly:

- Apache 2.4.6
- PHP 7.1
- MySQL Ver 15.1 Distrib 5.5.52-MariaDB
- Wordpress

## 7.5 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.

## 7.6 Software Proposal

The EDICULA consortium is oriented to adopt a free, open-source software learning management system (i.e., WordPress, LearnPress, LearnDash) powering learning environments worldwide. It is designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalized learning environments.

In this work we are going to represent the tool of WordPress, which is in the scope of this deliverable. The adaptation of the educational management system will be used for blended learning, distance education, flipped classroom and other e-learning projects for the open public. The multidisciplinary objectives of the EDICULA project will be addressed taking into consideration that the adopted educational toolkit will



encompasses customizable management features. The EDICULA toolkit will allow for extending and tailoring learning environments using community sourced plugins.

## 7.7 EDICULA-4-All Administration Management

The EDICULA-4-All is developed using WordPress. The editing of the EDICULA-4-All website can be achieved from the link <http://edricula.eu/wp-admin/>. The environment of the login page is displayed in Figure 14. After log in the WordPress development page offers a wide variety of possible actions. In this deliverable case, the needed action is to create a new course, which can be achieved by selecting “LeanPress -> Courses” (Figure 15), which loads the courses content organization in the platform (Figure 16).

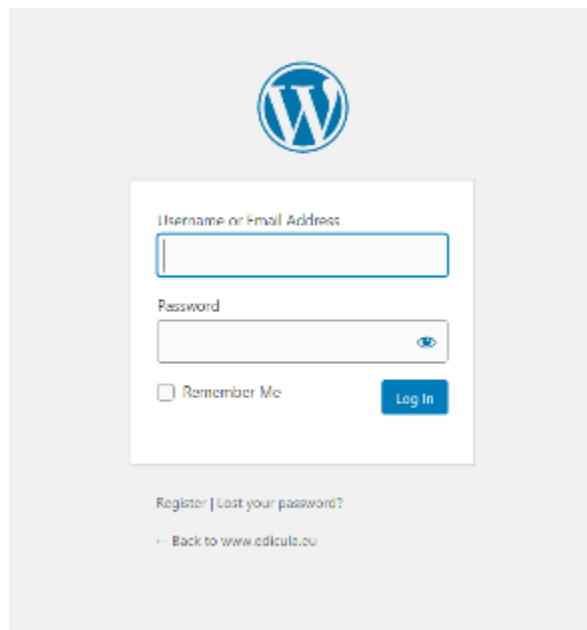


Figure 14. Administrative log in page.

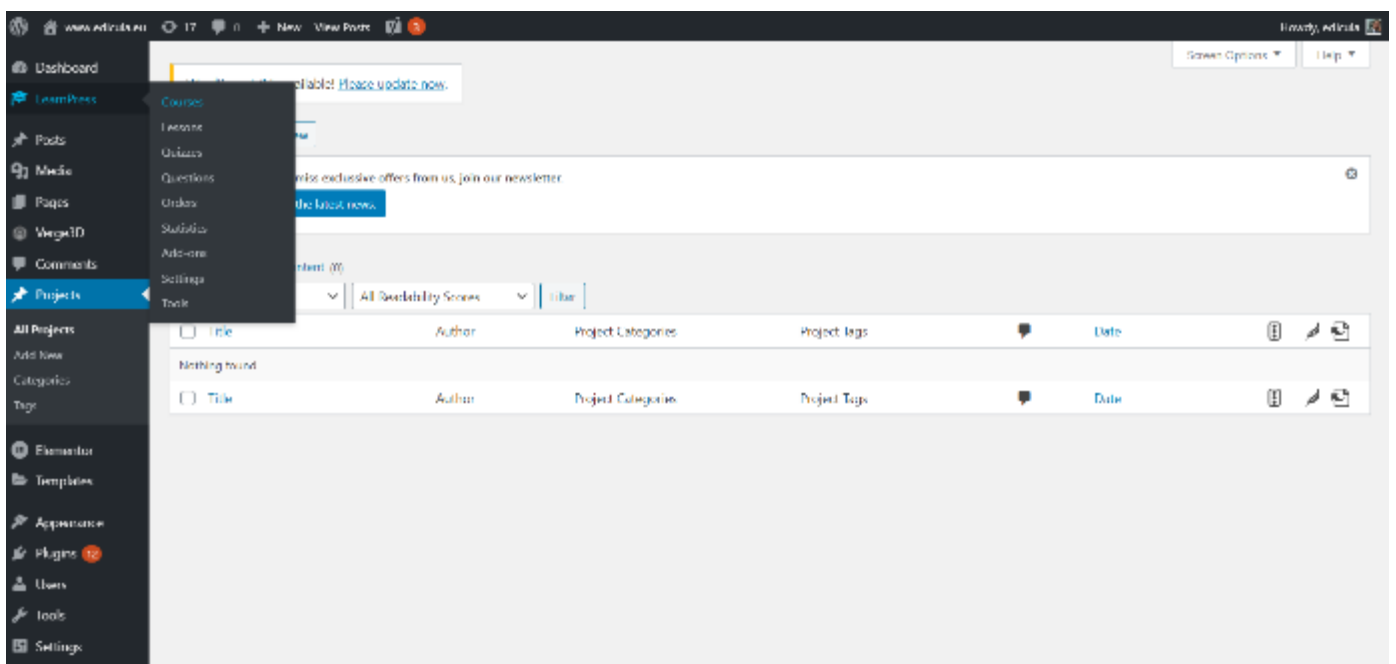


Figure 15. WordPress after log in page.



By selecting the “Add New” (circle 1) option, as shown in Figure 16, a new course can be created from the editing page (Figure 17). The same page can be loaded, also, for editing an existing course by clicking the option “Edit” in circle 2 (Figure 16). Simple editing is, also, possible from “Quick Edit” option. To delete a course the platform has the “Trash” option, which is in red font colour. “View” option loads the course screen, the users can see (Figure 23) and “Duplicate this course” create a new course with the same parameters.

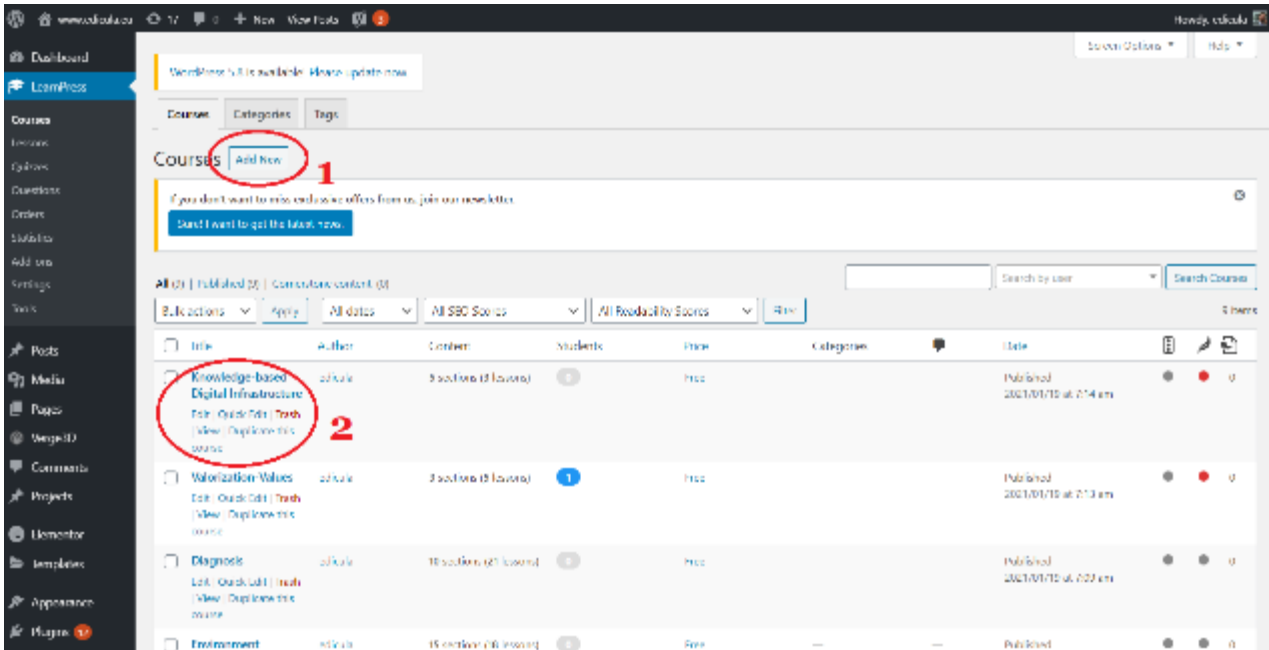


Figure 16. Courses content organization in the platform.

As an example, in Figure 17 a new course named “Architectural Analysis” will be created. The name of the course needs to be typed in the first line edit, as depicted in Figure 17. In “Curriculum” (circle 1 in editing page - Figure 18) options, new sections and lessons can be added to the course (circles 2 and 3 respectively in Figure 18). After clicking “Save Draft” option (Figure 17) the course is created/edited and can be accessible from the course page (Figure 19)

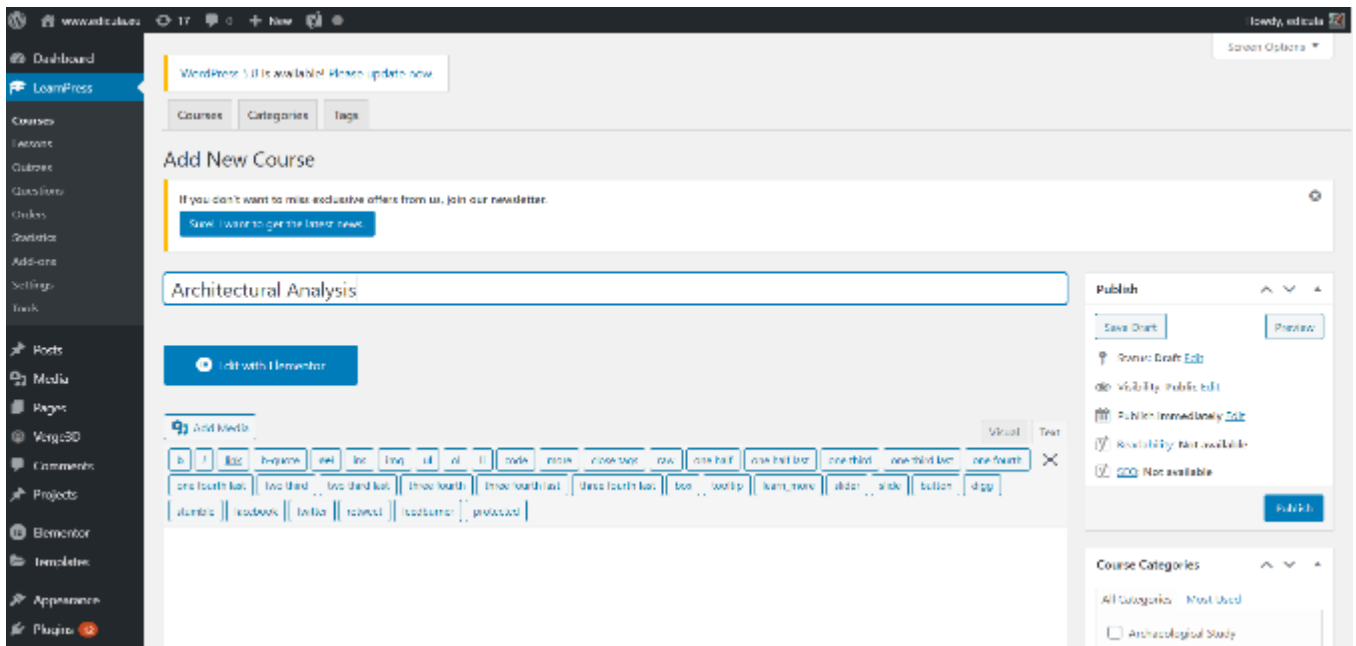


Figure 17. Courses editing page. Is accessible by selecting “Add New” or “Edit” in the courses content page.

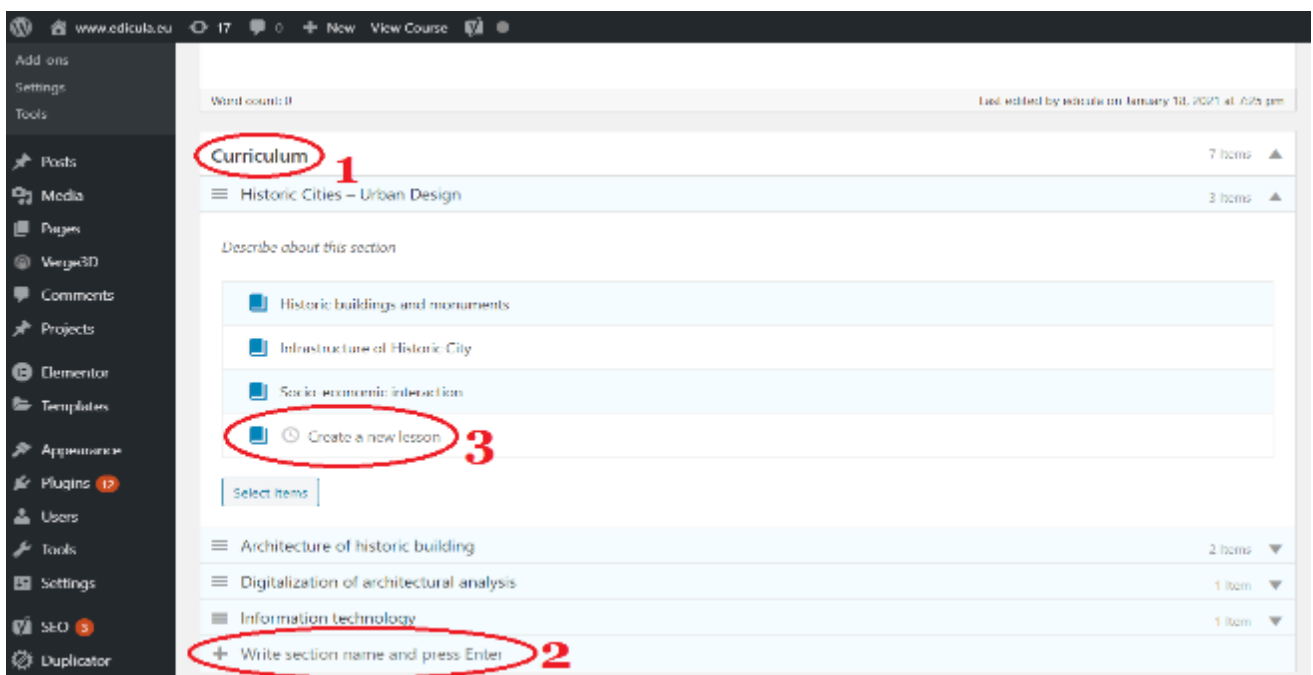


Figure 18. Editing Architectural Analysis page

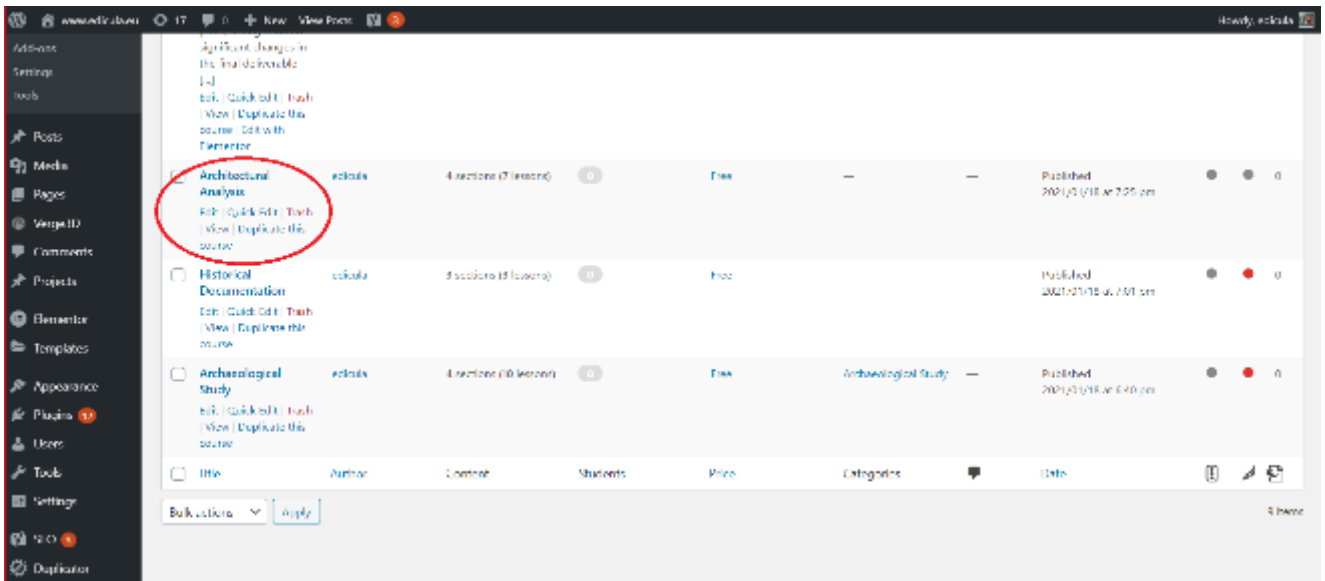


Figure 19: EDICULA courses content after creating “Architectural Analysis” course

WordPress includes, also, the option for viewing the published site. This option is accessible by clicking the name of the webpage ([www.edicula.eu](http://www.edicula.eu) in this project case) and then “View Site” option, in the upper left of the WordPress pages (Figure 20). Figure 21 depicts the loaded page of [www.edicula.eu](http://www.edicula.eu) and by selecting “Courses”, the user has access to the accessible courses of EDICULA-4-all, for enrolment. In the example above, the newly created Architectural Analysis is free and accessible for enrolment in EDICULA’s webpage Courses section (Figure 22). By clicking on it, the enrolment page (same page as clicking the “View” option inside WordPress courses editing page) will be loaded and finally the user can enrol in this course (Figure 23)

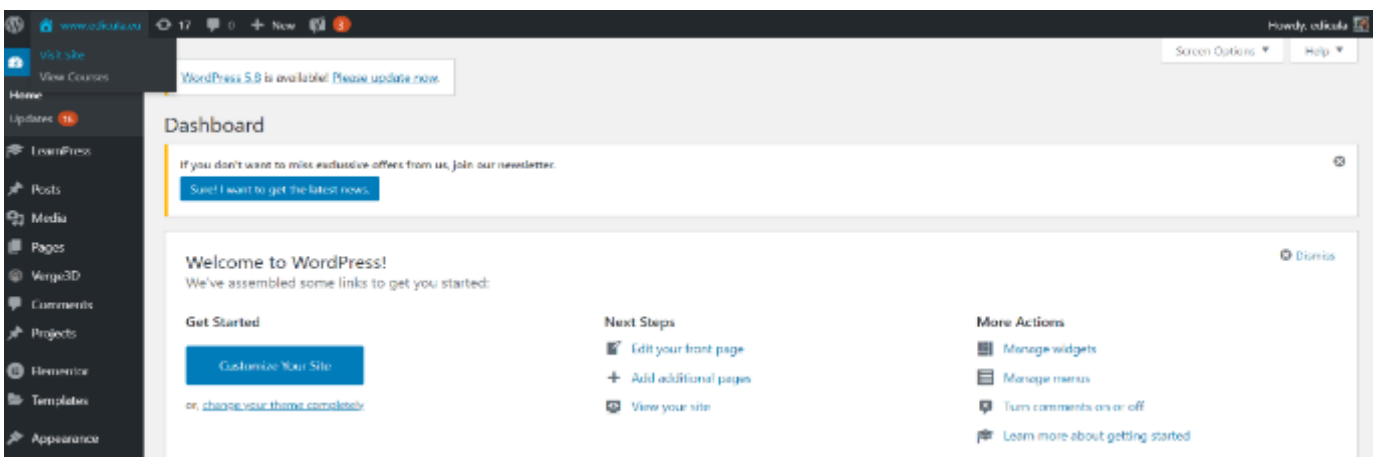


Figure 20: Select “View Site” to load the [www.edicula.eu](http://www.edicula.eu) public webpage.





# EDICULA

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**EDICULA** "Educational Digital Innovative Cultural heritage related Learning Alliance" is a **Strategic Partnership for Higher Education in Erasmus+**. Strategic Partnerships aim to support the development, transfer and/or implementation of innovative practices at organizational, local, regional, national or European levels. Institutions of Higher Education work with others (other sector fields, enterprises, social partners etc.) to help to improve higher education across Europe and to deliver high quality education which is relevant to national and European labor market needs.

A major challenge for Europe and the world 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'.

Figure 21: EDICULA website – Introduction – Informative Screen

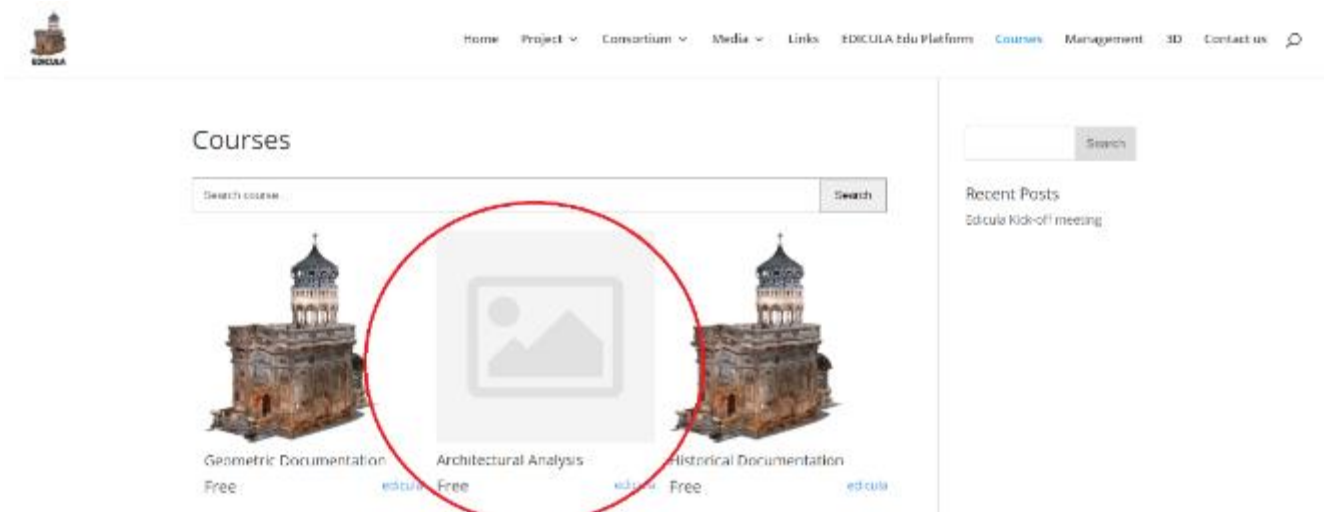


Figure 22: EDICULA's webpage courses section. The newly created Architectural Analysis course is accessible to the public from this page.



## Architectural Analysis

### Curriculum

- **Historic Cities – Urban Design**
  - Historic buildings and monuments
  - Infrastructure of Historic City
  - Socio-economic interaction
- **Architecture of historic building**
  - Retrieval of information from archives
  - Creation and analysis of architectural plans
- **Digitalization of architectural analysis**
  - Virtual models
- **Information technology**
  - IoT & Historic Cities

Free

Enroll

Figure 23: Architectural Analysis course enrolment page.



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## Conclusions

In this deliverable we described the EDICULA-4-all platform. The aim of EDICULA project and why it is important for the public to have access on this platform. The deliverable, also, described the EDICULA-4-all management policy and all the technical approaches for the creation of WordPress webpage. A brief description of the administrative privileges is, also, included in the deliverable, in addition to the hardware requirements and other technical information about the server hosting and user accessibility.