



Citation: Pigaki, M. & García Martínez, C. (2024). Developing MOOCS as a Teaching and Learning Approach in Cultural Heritage Studies. *Bollettino della Società Geografica Italiana* serie 14, 7(2): 77-89. doi: 10.36253/bsgi-7451

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Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

Developing MOOCS as a Teaching and Learning Approach in Cultural Heritage Studies

Sviluppo dei MOOC come approccio all'insegnamento e all'apprendimento negli studi sul patrimonio culturale

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Abstract. How can the teaching-learning of the complexity of cultural heritage adapt to new technological changes? How should geospatial tools be used for cultural heritage management in all its aspects? These questions are highlighted in this paper, which focuses on the conceptualization of spatial thinking and the need to master digital skills to improve knowledge of cultural heritage. As a practical result of the theoretical discussion, the study presents the experience of designing a massive open online course (MOOC) on *Geotechnologies for Cultural Heritage* within the MINERVA project and discusses its implications for improving the digital training of students in this field. The results of experimentation in new pedagogical approaches and technologies in teaching and learning, such as those in this MOOC, on the one hand, offer teachers a clear opportunity to reflect on and expand their teaching methods, and, on the other, present students with innovative practices through spatial tools. These tools can help formulate new avenues of development for action, capable of responding to contemporary needs and challenges in the field of cultural heritage.

Keywords: MOOC, cultural heritage, geotechnologies, teaching-learning strategies, spatial thinking.

Riassunto. Come può l'insegnamento-apprendimento della complessità del patrimonio culturale adattarsi ai nuovi cambiamenti tecnologici? Come dovrebbero essere utilizzati gli strumenti geospaziali per la gestione del patrimonio culturale in tutti i suoi vari aspetti? Sono queste le domande evidenziate in questo contributo, che si concentra sulla concettualizzazione dello *spatial thinking* e sulla necessità di padroneggiare competenze digitali e migliorare la conoscenza del patrimonio culturale. Come risultato pratico della discussione teorica, nel contributo è presentata l'esperienza di progettazione di un MOOC di *Geotecnologie per i Beni Culturali* all'interno del progetto MINERVA, così come le sue implicazioni per migliorare la formazione digitale degli studenti. La sperimentazione su nuovi approcci pedagogici e tecnologie nell'insegnamento e nell'apprendimento, come questo MOOC, fornisce, da un lato, agli insegnanti una chiara opportunità di riflettere e ampliare i propri metodi di insegnamento e, dall'altro, mostra agli studenti pratiche innovative attraverso strumenti spaziali. Infatti,

questi strumenti possono contribuire a formulare nuovi assi di sviluppo per l'azione, in grado di rispondere alle esigenze e alle sfide contemporanee nel campo del patrimonio culturale.

Parole chiave: MOOC, beni culturali, geotecnologie, strategie di insegnamento-apprendimento, pensiero spaziale.

1. Introduction

This paper presents a didactic proposal aimed at introducing geotechnologies for the research and study of cultural heritage, through a MOOC (Massive Open Online Course) designed for this purpose. The first part emphasizes the changes and challenges facing education in cultural heritage, which justify the need to adapt current teaching-learning strategies to the characteristics of the contemporary social context. In the second part, we analyse the methodological foundations of this proposal intended to develop spatial thinking. Particular attention is devoted to the cross-cutting learning strategy used (case studies). The main results are then presented, with a synthesis of the design and content of the course, created as an open educational resource (OER), thanks to the MINERVA project (Mapping Cultural Heritage. Geosciences Value in Higher Education). Finally, the contributions to the acquisition of spatial skills applied to cultural heritage (CH) are evaluated.

2. The complexity of the teaching-learning process of cultural heritage

The appearance of technological applications and digital tools of increasingly accessible use has facilitated *spatial literacy*, a type of learning that is necessary to develop critical thinking applied to space, understood in all its depth, because, as Santos contends, it is constituted not only by things but also by relationships. Space must be considered an inseparable set comprising, on the one hand, a certain arrangement of geographical objects (both natural and social), and on the other, the life that fills and animates them, society in movement (Santos 1996, 28). The material configuration of space, through a set of forms, is the expression of the society that manifests itself through them. Therefore, society cannot be separated from space and, in this sense, the idea that society becomes space can be understood.

This training implies a set of skills that are essential for the development of our daily activities, which, in addition, can be applied to highly diverse fields, includ-

ing that of cultural heritage. In education, we are currently immersed in a process of applying information and communication technology (ICT) to highly varied areas of knowledge (even to some that seem more alien to this type of tool). This means going beyond the goal of learning technologies to focus on learning *with* technologies, which has given rise to the name of knowledge and learning technologies (KLT).

In the case of cultural heritage, analysing, managing, and disseminating its now fully recognised spatial dimension requires digital skills related to spatial thinking; skills which must be included in the teaching-learning process.

2.1. The spatial dimension in the concept of cultural heritage

The definition of what we understand as heritage has broadened over time, encompassing more types of assets, and adding the spatial or environmental component (Feria 2012). Since the mid-20th century, an evolution has occurred, changing the static vision of heritage (fundamentally considered as a set of material assets, of which the most outstanding are those of an architectural nature) as being located in space, which, in turn, is understood as a support or passive container of cultural heritage. Over the decades, other elements, and values (such as intangible assets) have been added to its definition, while the importance of its spatial dimension has been recognized. Space is beginning to be considered not only as a support but also as a basic factor, both conditioning and expressing social processes.



Figure 1. Pond built as part of the hydraulic system in the cultural landscape of Riópar, Spain (case study). Source: own preparation.

Thus, we arrive at the current moment in which a double process can be observed: on the one hand, heritage is beginning to be seen as a constitutive part of a more complex spatial system and as something that is built in the dynamics of the present. On the other hand, the perceptions of individuals or groups are considered. Hence, the notion of landscape as the territory perceived by the population, resulting from the interaction of man with the environment over time, being a legacy with patrimonial values, makes full sense at this time.

2.2. Changes and challenges in the educational context

Using spatial thinking to perform a wide range of everyday tasks (from finding the nearest school to parking a car) is not the same as the concept of spatial literacy. The latter is defined as the type of skills used to describe and analyse the spatial patterns of people, places, and environments on Earth. These are skills that must be developed by students that are interested in society and its reflection in space (i.e. those who deal with cultural heritage). However, there is a lack of focus on spatial thinking in studies of cultural heritage, and the social sciences and humanities in general, as has been recognized by various authors (Hespanha 2009).

In the educational context, three changes can be highlighted, which, among others, are shaping the current stage of development. They are transformations common to those occurring in other areas and are the result of the evolution of society and technology.

First, everyone today has free access to large amounts of information. Data of all types (economic, social, demographic, etc.) are immediately available from the very moment they are produced. This information comes from different sources; some are formal (academic or institutional, for example), and others are of an informal or voluntary nature. Among the latter, the so-called neogeography has prospered.

Secondly, another characteristic is the availability of technological tools that are also freely accessible (in the form of specialized software). These are increasingly important in the teaching-learning process and are part of open educational resources (OER), which are now notably more varied and complete. They have been defined as accumulated assets that enable the development of individual or social capacities for understanding and action. There is a great diversity of OER, the characteristics of which include their being freely used without interfering with the use of others, while providing non-discriminatory access to the information and services they generate. Depending on the degree of openness, the

possibility of their being modified by users can also be added (Tuomi 2006, 35). These include geospatial tools, dedicated to the spatial treatment of data (such as GIS, among others), which are of particular interest for questions related to cultural heritage.

Thirdly, the possibility for any person to rapidly create and disseminate content (which does not guarantee it is necessarily accurate or reliable) is another of the characteristics of our time. There are countless examples of blogs, wikis and other procedures that serve this purpose.

Each of these changes emerge as challenges to which the education system must respond. The first great challenge is related to the need to improve the capacity to manage and optimize the flow of information that students receive so they are not overwhelmed by the large amount of data, opinions, theories, etc. available. The selection of relevant and reliable information is undoubtedly one of the challenges that teachers and students face. This initial task, which requires specific procedures and criteria, is necessary to leverage the potential that new technologies make available to the current educational system.

Another challenge is to promote the training of young people in technological tools and to improve their digital skills (be these knowledge, attitudes, or abilities). The EU has been engaged in the task of improving digital skills for many years, with a view to completing what is known as the digital transformation of the world. In this sense, it is one of the eight key competencies contemplated in lifelong learning. The Digital Education Action Plan, launched as a result of the Gothenburg Social Summit (in 2017), addresses the same objective. Here, we will focus specifically on the teaching-learning of geotechnologies, since they improve skills not only in spatial thinking, but also in spatial literacy (or critical thinking about space as an expression of society).

The third challenge refers to the quality and depth of the content on which academic curricula are focused, forcing a reflection on the ultimate purpose of the teaching-learning process and, ultimately, of the teaching activity in question. In the case of the sciences that deal with cultural heritage, which include geographic space understood as a manifestation of society, it is necessary to focus on critical thinking on key notions like that of geographic space. The teaching-learning process is not restricted only to the acquisition of technological skills, even though these are absolutely necessary. Such skills should contribute to the ultimate goal of fostering the development of autonomous and critical thinking. In short, technological tools, in their different categories, are essential in current educational practice. This involves the use of both low-tech tools, that is, tradition-

al ones (such as a simple paper or pencil) and high-tech applications (Excel, PowerPoint, Photoshop...), since all of them can be used to support spatial thinking.

2.3. *The need to develop spatial thinking for cultural heritage*

Although academic progress necessarily entails the use of a growing range of spatial competencies, spatial thinking is insufficiently recognized (from the initial levels of education) and given scant value, and therefore has a limited presence in school curricula (Sinton et al. 2013).

Some authors differentiate between spatial thinking (which can be considered as a set of abilities to visualize and interpret spatial concepts) and geospatial thinking, understood as a specialized form of spatial thinking that focuses on the patterns and processes that take place on the Earth's surface. Geospatial reasoning skills are high-level cognitive processes that provide the means to manipulate, analyse, interpret, and explain information, solve problems, or make decisions at geographic scales (Baker et al. 2014, 3), and include visualization capabilities.

The use of geospatial technologies (and therefore GIS) involves both spatial thinking, in a broad sense, and geospatial thinking. Despite the lack of research supporting and verifying the relationship between the development of geospatial thought and the use of geotechnologies, a reciprocal relationship between the two can be recognized (Sinton et al. 2014). The acquisition of basic geospatial thinking skills, such as defining a problem, proposing solutions, or interpreting results, are prerequisites for solving spatial problems. The reverse is also true, since geotechnologies facilitate the set of activities that are necessary to identify spatial patterns, such as the visualization of spatial relationships or analysis and query of geospatial data. Maps and representations from GIS, for example, allow us to obtain information that would be difficult or impossible to acquire from direct experience and that is necessary to find spatial patterns. The idea of the world is today mediated by the technology available, since we learn to think about it through the images and content it makes available to us, which influences spatial thinking in general and geospatial thinking, in particular.

3. Theoretical and methodological framework

The four core geotechnologies are GIS, remote sensing, global positioning systems (GPS) and digital globes. What is the value of this set of tools in the research,

management, and dissemination of cultural heritage? This section presents the potential of applying these tools to cultural heritage. The methodological foundations of the MINERVA project, which focuses on promoting spatial thinking in this field of knowledge, is also analysed.

3.1. *Potential of geospatial tools for cultural heritage*

In order to systematize the functionality of heritage technologies, it is possible to identify several types of tasks, which, in fact, are not independent of each other and give rise to three interrelated groups: a) Those dedicated to inventorying/documenting heritage (including actions such as registering, locating, identifying); b) Those that are oriented towards acquiring, processing and analysing patrimonial data; c) Those aimed at disseminating data on heritage, on its characteristics, and generating new experiences about it.

a) New technologies and digitization play an essential role in the present and future of the conservation and dissemination of cultural heritage in general. In fact, the European Union has promoted the *Declaration of cooperation on advancing the digitization of cultural heritage*, a document signed in 2019 by 25 member states, Norway, and the United Kingdom. The digitization of cultural objects has great potential to generate social and economic benefits for activities related to tourism, education, and the creative sectors (European Commission 2019).

Therefore, for example, in the last 10 years a large number of heritage inventories have been created that use GIS (such as the georeferenced catalogue of the cultural heritage of Andalusia, Spain) (Junta de Andalucía, 2023), or the Mapping Ancient Athens project, a web mapping platform that locates and characterizes the archaeological remains in this city identified and published from the 19th century onwards (Dipylon 2023).

b) Complementary to the previous ones are the tasks used to acquire and analyse data on heritage. There are numerous examples of works that show the possibilities offered by remote sensing systems, or GIS for studies on different heritage assets (archaeological, artistic, landscape, etc.).

c) On numerous occasions, cultural heritage is deteriorated or has even been destroyed. Geotechnologies help us to document and give new life to what is lost or deteriorated. Digital representations of cultural heritage can be made that may serve as digital surrogates for the real world. They may not only be used for leisure, play or personal enjoyment, but also permit viewing

(under optimal conditions) and scientific study without the need for physical experience of the object or place. In this task, technologies such as photogrammetry, 3D modelling, Global Positioning System (GPS) and various types of software that allow for the generation of much more efficient and precise 2D and 3D information than a few years ago are extremely useful.

3.2. Significance statement

Spatial processes concern the locations of objects, their shapes, their relations, and the paths they take as they move in space and time. Recognition of spatial knowledge in the CH field enriches the traditional educational focus on developing literacy and skills to include a cognitive domain that is particularly relevant to achievement in both education and research.

How should geospatial tools be used in cultural heritage education in all its various aspects? Which didactic process is most effective in developing students' spatial reasoning? What actions must be applied? Which methods should be used?

The following sections of this chapter describe the process that refers to (a) the cognitive process of understanding space, and (b) the relationship between spatial thinking and didactic methods that guides two strategies for exploiting these approaches in a MOOC environment. That is, Strategy 1 involves development of spatial cognition using geoscience components that result in criteria and process. Strategy 2 involves spatializing the CH curriculum, via didactic material, using a case study approach suited to spatial thinking, including spatial language, maps, diagrams, graphs, analogical comparison and argumentation.

For the first strategy, we analyse the cognitive process (1) across different teaching-learning approaches in e-learning environment, and (2) for students of different initial spatial skills backgrounds. Referring to the latter, we explain the didactic material of the MOOC as a cognitive process of spatial awakening in CH education, drawing on the strong link to the curriculum and the inherently spatial nature of our world to move towards to a new paradigm. More holistically and qualitatively, we determine the steps in which CH students engage via spatial activities within and across the respective goals of the development of the spatial thinking approach in CH education. This helps students to allocate study time reasonably and enhance self-regulated learning (SRL) and the self-perceived process.

Self-regulated learning means that all students need to be able to use goal-setting, self-monitoring, effective

self-instruction and self-reinforcement. Self-perceived overall competence is defined as a personal characteristic that reflects an individual's global expectation or belief in their ability to accomplish tasks (Eccles, Gootman 2002; Pajares, Schunk 2005). The importance of self-perceived overall competence in positive youth development has been demonstrated and has been shown to serve to improve students' learning effectiveness and performance.

3.3. Spatial thinking process

Spatial thinking is an intellectual process supported by one or many "pictures" of space. Consequently, we cannot ignore the fact that developing spatial thinking can be facilitated using various "pictures" of space. As a result, to approach and then describe space, there is a need for methods and tools that record and depict it, aiming to familiarize students with the three major components of spatial thinking, namely, cognition *about*, *in* and *with* space.

Spatial thinking includes processes that support knowing, understanding, and planning. An expert spatial thinker visualizes relations, imagines transformations from one scale to another, mentally rotates an object to look at its other sides, creates a new viewing angle or perspective, and remembers images in places and spaces. Spatial thinking begins with the ability to use space as a framework. Furthermore, an object can be specified relative to the observer, to the environment, to its own intrinsic structure, or to other objects in the environment. Each instance requires the adoption of specific spatial frames of reference or context. In other words, the spatial context is critical because it is the space in which we find the data that ultimately determines its interpretation. In fact, we are thus actually mentioning three spatial contexts, physical space, intellectual space, and representational space, which require a student's cognitive transposition in two linked steps.

In the case of physical space, where space functions as an object of knowledge, there are two cognitive transpositions that create the background for spatial thought. The first of these is related to the passage from the identification of the objects and places *about* space into their physical context, referring to understanding. Intellectual space, as an instructive spatial tool, activates the analysis of spatial characteristics and their relationships, which, in turn, promotes student's participation in the process of understanding *in* space. The third stage is related to the passage from the intellectual space to the representational space, through images and symbols as an arte-

fact of knowing, which activates the didactic process of applying knowledge, promoting the implementation of different scenarios and solutions *with* space.

3.4. Case study approach as a cross-cutting learning method

The previous description shows that the spatial thinking process requires different teaching-learning approaches through cognitive processes for students' spatial thought development. Additionally, it is a fact that the emergence of MOOC as a course delivery technology has changed the landscape of distance education. A case study as a learning experience of students in a CH curriculum is implemented, with an emphasis on student approaches to spatial knowledge construction. In other words, it focuses on a constructivist approach that aims to produce new understanding or knowledge in CH, in a spiral manner. In fact, on the one hand, the case study is an essential method increasing students' knowledge construction when linked to other method, while, on the other, the case study approach acts as an organic pedagogical component of the assimilation of the research question, which is influenced by the attitudes, behaviour and learning approaches of the student members in the team. Thus, it develops student's capacities to enhance their self-regulated learning and self-perceived overall competence.

The case study method enables a researcher to closely examine the data within a specific context. In most cases, this method selects a small geographical area or a very limited number of criteria as the subjects of study. Case studies, in their true essence, explore and study a case as a lever method investigating contemporary real-life phenomenon through detailed contextual analysis of a limited number of events or conditions, and their relationships. Yin defines this research method as follows:

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the object of study and context are not clearly evident. It copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to coverage in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis (Dul, Hak 2008, 4, as cited in Yin 2003).

According to this overview, self-perceived overall competence means that all students need to be able

to process according to goal-settings, self-monitoring, effective use of self-instructions and self-reinforcement. For this purpose, case study methods are activated with a spiral form of learning to help students to acquire knowledge *about* space, to understand *in* space and to apply *with* space. All the above obviously demonstrates that, to enhance spatial thinking, it is necessary to engage different strategies to achieve effective educational planning.

The case study method is implemented as an artefact to enhance the teaching-learning approach in both the CH and Geotechnology fields. This method is linked to a theoretical framework (Tellis 1997) aiming to achieve various learning methods according to the level of knowledge and the goal setting, with these being inquiry based-learning, problem based-learning and research based-learning. Accordingly, the Minerva didactic proposal is designed around a set of case studies based on PBL methodology, which activates three levels of spatial thinking, that is, the case study as a lever of knowing, *about* space, an intellectual spatial procedure of understanding, *in* space, and a representational space that refers to a "logic chain" of applying *with* space.

Moreover, a set of didactic material was designed that contains the theory part via video lecture and a step-by-step training, to accomplish assignments such as guided practice, that is, guided exercises embedded with guided instructions. At the end of each part of a set of activities, a questionnaire is provided to be filled in by the students. At this stage, the case studies designed are focused as follows: An introduction that presents the context, the aim of the case, description of the skills involved and level of competences, the workflow and finally the set of data needed.

3.4.1. The case study as a lever of knowing: about space

This type of case study seeks to instil curiosity about a specific question in a student. It aims to conceptualize the process of knowing in spatial terms expressed through two questions: "What is it?" and "Where is it?" That is, through queries *about* space, the aim is to help CH students to participate in two related functions with respect to managing/understanding geospatial data by observing and recalling. By doing so, they will be able to answer the fundamental questions of the previously mentioned knowledge process, as a result of having the necessary spatial skills. In fact, geoscience studies require the use of numerous spatial tools and techniques included under the term geographic skills. In this process, CH students can ask geographic questions, acquire

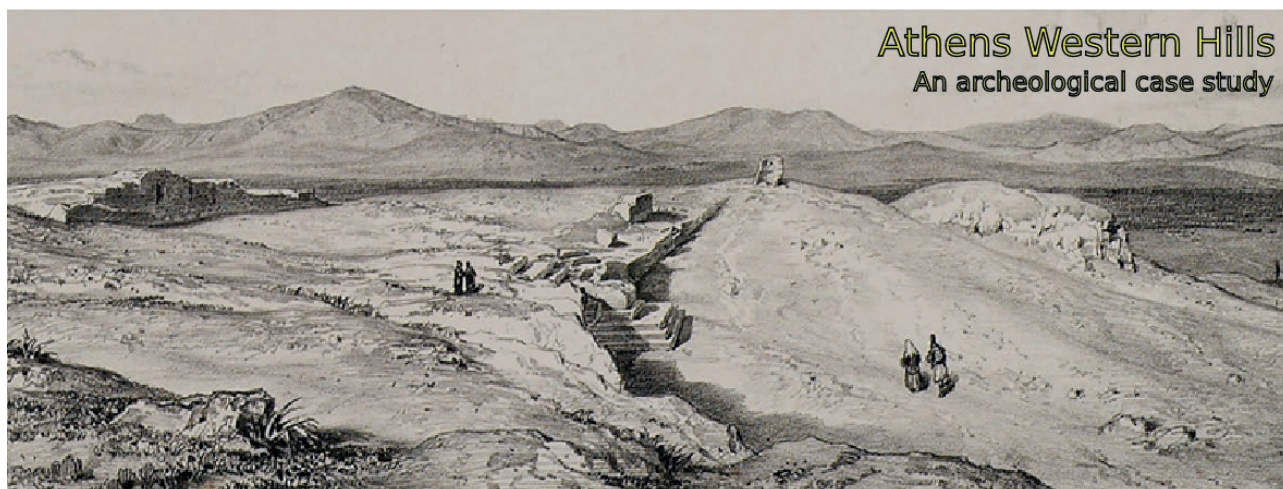


Figure 2. A Case study about archaeology in Athens. Source: Geotechnologies for Cultural Heritage MOOC.

spatial information and organize it. The case study activities established draw on inquiry-based learning (IBL). This is an active student-centred form of instruction in which students are required to present a solution to a clearly defined authentic problem. This method emphasizes knowledge related to “how”, which means how spatial knowledge is acquired. These cases study activities are designed for the purpose of “reading” a real spatial problem with a well-constructed questions through basic spatial skills, to enhance a student’s basic spatial skills.

3.4.2. The case study as an intellectual process: in space

Case study activities, as teaching-learning strategies, focus on relating data to real-life problems, using various sources of documentation. This process requires understanding space and its features and beyond; it is a process that links data to its spatial context. It is based on the potential of problem-based learning, that is, strengthening the teaching of real-life problems by analysing a ‘structured’, ‘guided’ and ‘open’ inquiry set of activities. It initiates the relation between teaching and research that leads to a reconceptualization of inquiry-based learning, which, in turn, activates the process of understanding *in space*. This process is expressed by, at least, three questions: “Why is it there?”, “How did it get there?”, “What is its significance?” In terms of CH instruction, therefore, the focus is on students being able to attribute meaning to what they observe and mainly to explain it; in other words, to understand the subject matter of CH linked to its spatial context. Project-based learning gets students directly involved and actively working toward solutions.

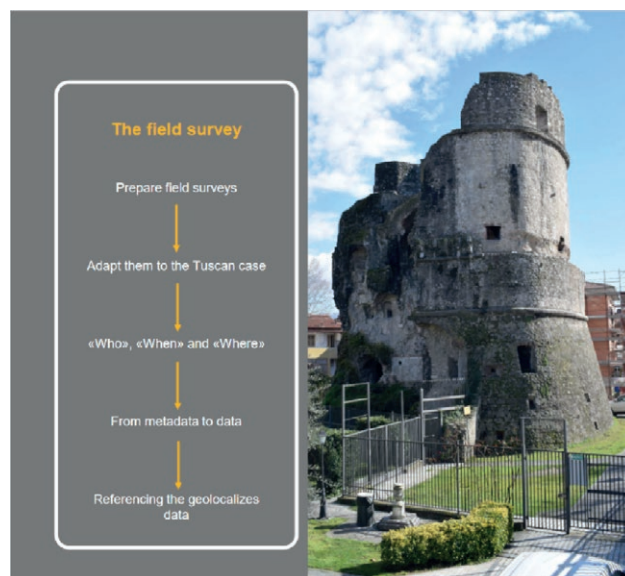


Figure 3. Training activity methodology in a case study. Source: Geotechnologies for Cultural Heritage MOOC.

3.4.3. The case study as a logical chain: with space

This process is expressed by the commonly posed question: “How can spatial knowledge and understanding be used to enhance research in CH?” This process involves problem-solving processes, formulating hypotheses, and generating solutions to problems and, in general, applying geographic knowledge to real life situations in a practical manner. This, of course, involves the learning of all the analytical concepts and principles that provide students with the ability to comprehend and

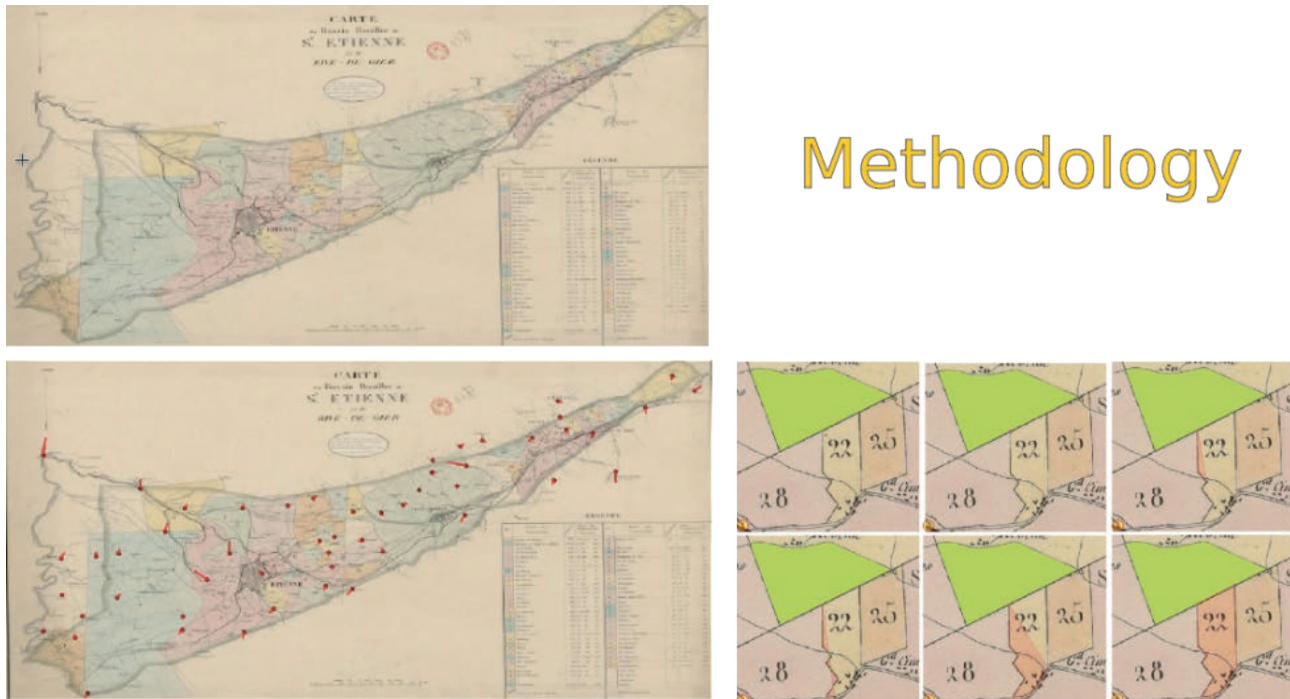


Figure 4. Case study: Loire coal mining basin. Source: Geotechnologies for Cultural Heritage MOOC.

find connections between diverse elements of geographic information and to use that information to explain patterns and processes in space. As a result, CH students comprehend and deal with complex contemporary issues by learning skills and understanding their subject matter to solve real problems, working *with space*. Additionally, in doing so, they interpret the results through their own hypotheses. Research-based learning promotes a student-centred approach that can strengthen the links between teaching and research. Thus, doing with understanding means activities that link research and project-based learning. In other words, they can learn to think critically and creatively. Students are provided with the opportunity to use the information they have collected to compare and contrast, interpret, apply, analyse, synthesize, open discussions, formulate a ‘chain’ of logical procedures, summarize results, solve problems, make decisions, and verify key questions.

4. Planning a MOOC on Geotechnologies for Cultural Heritage

In order to use a MOOC and its content as a key topic, there are many references that describe the tools and techniques for empowering learners in a new pedagogical context. However, in the case of CH, there are

challenges pertaining to teaching-learning approaches as well as others related to university curricula and life-long learning programs. In fact, the challenge lays in the pedagogical content, which requires a different process. On the one hand, the knowledge of geotechnologies must be tackled, and, on the other, spatial software, such as GIS, must be used as an interdisciplinary tool for teaching CH. This process is expressed by the following questions: “How can GIS benefit teachers of CH to enhance their students’ learning? And “How can spatial knowledge and understanding be used to solve problems in CH?”

This part is devoted to presenting the MINERVA project framework of teaching geotechnologies in CH as a tool to invigorate instruction and provide innovative content delivery in CH teaching-learning. The project uses these technologies to increase student’s spatial perception and reasoning in a MOOC environment. Nonetheless, using GIS in CH teaching does not actually constitute an innovation, but, if approached as a cognitive object, and as an object of spatial knowledge, it represents a viable and optimal methodology for CH study and research. That is, using GIS as an experiential tool can create a positive effect on the development of spatial thinking, reasoning, and interpreting in the field of cultural heritage. As suggested by Kolb, such experiential learning, which involves concrete experience, observa-

tion and experimentation, is a feature of training provision (Kolb 1984).

4.1. A Cultural Heritage MOOC framework

The possibilities of Geographic Information System environments are being activated, and different tools are offered to facilitate interaction in CH fields. In fact, the pedagogic aims of this whole-group hands-on experience is conceived to familiarize CH learners with software functionality by performing analytic tasks using sample data, and to encourage them to reflect on its potential role for their own projects. For this purpose, the MINERVA project made a choice to use open-source and free-of-charge tools. This is justified because, first, it allows for better adoption by a larger community of teachers and students, and second, because Quantum GIS (the software selected) is a powerful desktop GIS for creating, editing visualizing, analysing and publishing geospatial information, providing a wide range of functionalities in both vector and raster modes. Figure 5 provides an overview of the existing open didactic material available on each module of the Geotechnologies for Cultural Heritage course, in the web-based lessons. The teaching and learning material are provided in different languages (e.g., English, French, Greek, Italian and others) and at different levels (such as Beginner 1, Beginner 1.2 and Advanced 2). References and resources used in the MINERVA MOOC and open data sources have been compiled by MINERVA project participants. Resources in different languages have been included and references to relevant “non-open” resources can also be found.

More specifically, the overarching modules allow a lecturer or a student to create conditional pathways through embedded material.¹ (1) The lessons’ content is designed according to the main components of geotechnologies. Each lesson consists of videos (with subDeveloping MOOCS as a Teaching and Learning Approach in Cultural Heritage Studiess in multiple languages), guided exercises (with downloadable data and documentation), bibliographical references and, when useful, in-depth discussions (web-community). (2) Learning activities for each overarching module are designed with the purpose of listening and attempting to understand the theory part via video lectures that lead to assignments (such as guided practice, guided exercises, and guided instructions), and ending with questionnaire and sev-

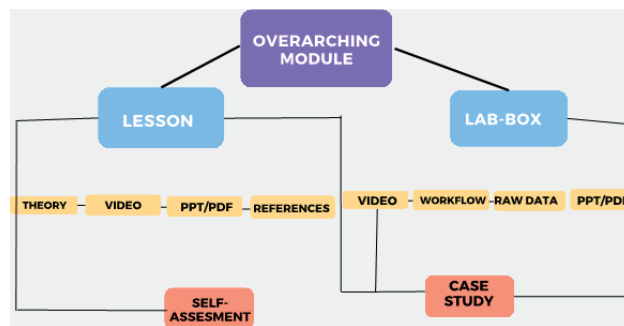


Figure 5. Teaching and learning workflow. Source: own preparation.

eral possible answers. (3) LAB BOX contains different case studies embedded in the content of lessons, as well as the overarching modules. (4) A self-assessment questionnaire is offered at the end of the module. Depending on a student’s choice of answers, they either progress to the next module or are taken back to a previous one. When students correctly answer a set of question, they are redirected to the next module based on their answer. In other words, a bank of questions is available to evaluate students’ process.

4.2. Teaching and learning pathways

The didactic material included in the overarching modules aims to guide a new curriculum approach in teaching and learning CH studies in order to add value to this field in the digital era. The content of the modules is designed with the aim of facilitating teaching and learning activities in two directions: the first, as a whole MOOC with graded didactic material for teachers and students, and the second, as a micro-MOOC, with modules used according to their own objective, that is, they can also be a supplement for stand-alone learning.

More specifically, the CH MOOC design contains five overarching modules highlighting geosciences processes in the CH field. These are: (a) Introduction; the introductory module aims to introduce GIS as a powerful tool for monitoring, managing and enhancing cultural and landscape heritage; b) Data acquisition, which focuses on producing a geospatial database; c) Data management, describing the ability to store, manage and integrate geospatial data; d) Data analysis, dedicated to explaining the key concepts of spatial analysis; and e) Data visualization, which is devoted to the visualization of geographic data, that is, the use of visual representations to make their spatial context and spatial relationships visible. A pre-training questionnaire is provided in order to evaluate a student’s background to guide them

¹ All the content of MOOC *Geotechnologies for Cultural Heritage* is available at: <https://moodle.minerva.identitaculturale.eu/>

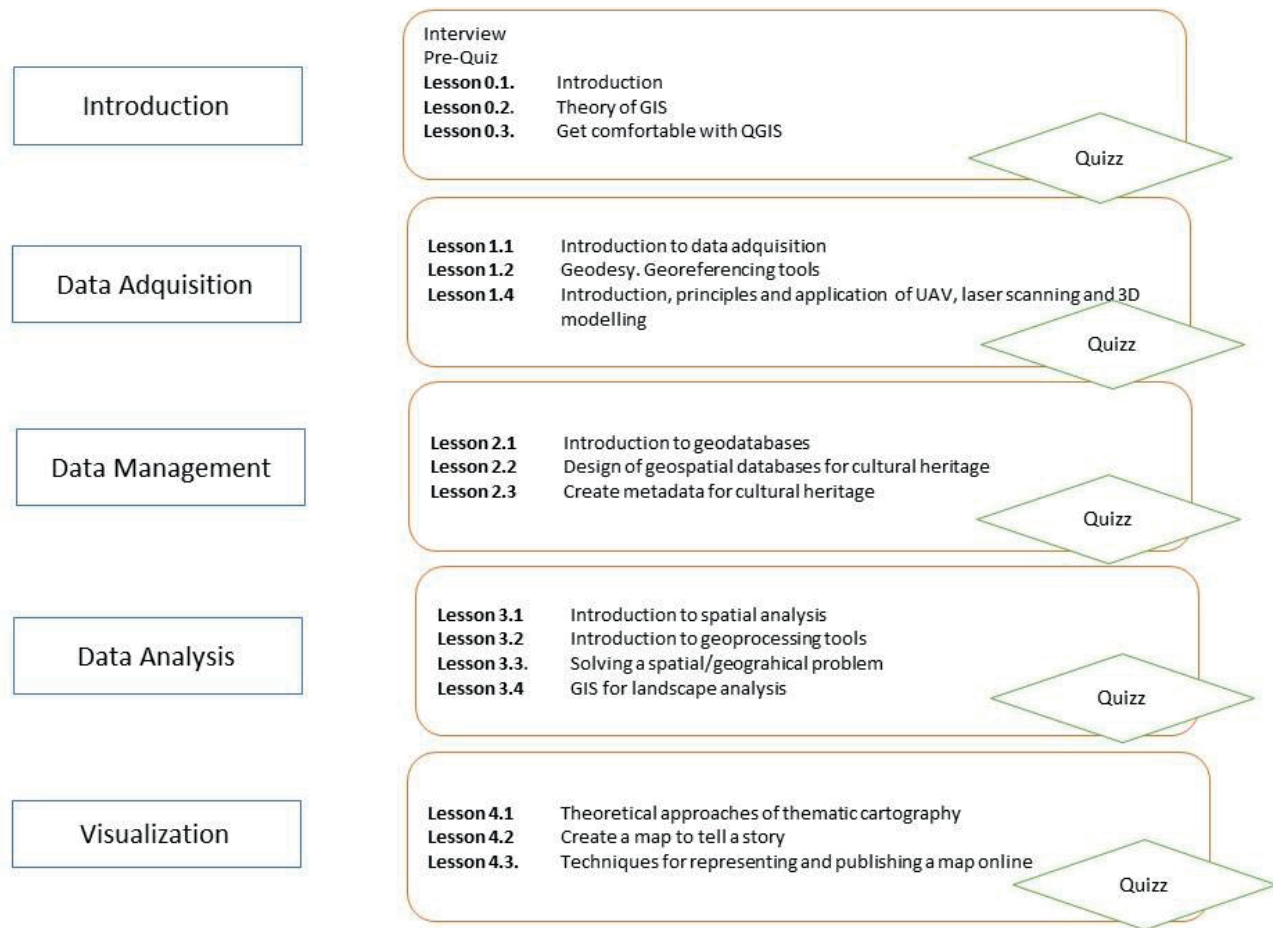


Figure 6. Framework of MOOC. Source: Geotechnologies for cultural heritage MOOC.

in an overarching module according to the respective levels, as mentioned above.

Each module includes several sections: (a) Modular description, outlining the content of the lessons of the module. (b) Video lecture, which is used to explain the theoretical part of a topic. (c) Teaser video, a trailer that provides information about the module content in order to create anticipation, spread awareness, and encourage enthusiasm about the topic. (d) Interview, which is an interactive, introductory, teacher-colleague activity to open the discussion about asking questions and defining problems in the CH field. (e) Interactive video, which supports guided instructions and guided exercises. (f) Guided practice, being an interactive exercise between the teacher and students. After the teacher introduces new learning, the student practice process it begins by engaging them in a similar task by simultaneously providing simple data. (g) Guided exercise, which is a process-oriented guided inquiry learning (POGIL) activity

that develops, implements, complements, summarizes, and enables application of the material contained in the previously viewed lecture, which students will complete later. (k) Guided instructions, which are step-by-step instructions in software operations for case studies and guided exercises. (m) Quizzes: these practice quizzes, allow students to increase critical thinking, and get into the habit of innovative learning. They integrate different types of mechanics into the learning process and will be discussed in the next section.

4.3. Assessment

The main goal of the MOOC (Bozhurt et al. 2017) is, therefore, to develop and integrate quality approaches, new pedagogies, and organizational mechanisms, with a strong focus on the learning processes (methodologies, and assessments).

The Minerva MOOC was designed, organized and evaluated in different steps during the project, to foster high-quality open education and learning in Europe and worldwide, in the quest for teaching and learning Geotechnologies to facilitate a new generation in CH. This was done considering both the learning processes and technological factors that influence the efficient retention and completion of the MOOC by participants.

Concerning the learning process, self-assessment is an important aspect of educational pedagogy because it is important for students to monitor and know whether they are really acquiring knowledge. Furthermore, the assessment of the MOOC refers to different criteria, both internal and external. On the one hand, it addresses the respective didactic material of the teaching and learning process, and on the other hand, it refers to the MOOC effectiveness according to overview criteria such as motivation, usability, and interactivity.

4.3.1. Learning system assessment criteria

Self-assessment is an essential part of any type of training. The right kind of assessment strategies help teachers/students to obtain the appropriate feedback. The problem of question answering can be described according to several different dimensions, each making the problem more, or less, complex (Hirschman, Gaizauskas 2001; Harabagiu et al. 2003; Moldovan et al. 2002). The level of spatial approach is distinguished by their overall purpose, or level of “understanding” (Hirschman et al. 1999).

To fulfil this objective, one of the strategies for self-assessment, in this instance, is to deploy quizzes for summative assessment per module. More specifically, the Minerva classification is based on Bloom’s taxonomy, known as the “Taxonomy of Learning Objectives”. These cognitive domains are aligned with the spatial process activated by the GIS processes, while their subcategories require cognitive “actions”, to achieve the learning objectives in both specific fields, which in turn underlines sensorimotor strategies. With respect to this goal, the MOOC evaluation system is applied to the level of learning objectives, that is knowing, reasoning, applying, and integrating skills, and goal setting.

The Moodle environment offers the possibility of creating more question banks, and, thus, all of them or a part of them can be used at any time they are needed. Different types of question answering approaches initiate different knowledge acquisition, which, in spatial terms, is expressed by ‘who’, ‘what’, ‘when’, ‘where’, ‘why’ and ‘what if’ related both to the Cultural Heritage and

Geotechnologies fields. The required answers are broadly linked to the respective lessons, to references, or to links to the web. Finally, all the answers to the questions are saved for future analysis. Thus, an analysis can be made regarding the evolution of the responses of participants over time.

During the process of developing the MINERVA MOOC an evaluation was carried out (Lu et al. 2021). This focused, on the one hand, on student-oriented research, using learners’ perceived benefits to determine the learning design through didactic methods and material (Jung et al. 2019; Lowenthal et al. 2018), while, on the other hand, it provided an assessment of the MOOC environment, in order to overcome the challenges, as well as to take advantage of future opportunities in MOOC development (Donitsa-Schmidt, Topaz, 2018; Gan 2018).

5. Instead of an epilogue

The MINERVA project, MappINg Cultural HERitage. Geosciences Value in Higher Education, focuses on two interlinked teaching-learning strategies, namely, internal, and external. The first activates methods for the purpose of enhancing spatial thinking by providing motivation through a corpus of real-life problems. Therefore, case studies and interviews, based on pedagogical methods (inquiry based-learning, problem based-learning and project based-learning), are used to enhance students’ achievement and perspectives, according to their respective goal settings. The second refers to the usability of the MOOC, which is activated by the easy access to complete course content and by making full use of platform resources.

In conclusion, this project promotes and develops innovative methods and tools for teaching, learning, and assessing geotechnologies in higher education contexts. In particular, it supports teachers, educators, and learners to use geotechnologies in creative, collaborative and efficient ways in the field of cultural heritage. MINERVA addresses the updating and development of digital learning materials, open pedagogies, and tools in the field of geotechnologies for CH, focusing on open educational resources through a free MOOC in its web learning platform. In general, MINERVA supports the effective use of digital technologies (especially GIS) through different methods. Introducing geographic information systems into the didactical process also develops learners’ spatial thinking. Hence, it is important for a MOOC environment to take into consideration the factors that influence student learning in their particular setting and to pro-

vide them with all the necessary tools to nurture deep learning approaches in PBL methods. The didactic material implemented, and the tools support our teaching and learning strategy, integrate the influences of cognitive factors through the proposed pathways, and play a major role in enhancing students' overall competences and skills in the subject matter.

Acknowledgements

We would like to thank all the partners involved in the MINERVA project (2020-1-IT02-KA203-079559), funded by Erasmus+, within which this paper has been carried out.

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