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**A MOOC designed for Geotechnologies teaching for Cultural Heritage Bachelor and Master students and teachers working in Higher Education institutions :
"MappINg Cultural HERitage: Geosciences VALUE in Higher Education" project, Intellectual Output 3**

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INTELLECTUAL OUTPUT 3

A MOOC designed for Geotechnologies teaching for CH Bachelor and Master students and teachers working in HE institutions

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1. About Minerva project

The project MINERVA: **MappINg Cultural hERitage. Geosciences VALue** in Higher Education promotes and develops innovative methods and tools for teaching, learning & assessment geotechnologies in Higher Education contexts. In particular, it supports European teachers, educators and learners to use geotechnologies in creative, collaborative and efficient ways in the field of geotechnologies for Cultural Heritage (CH).

MINERVA deals with the updating and development of digital learning materials, open pedagogies and tools in the field of geotechnology for CH, in particular focusing on Open Educational Resources through an open access and free MOOC (Massive Open Online Courses) web learning platform. In general, MINERVA supports the effective use of digital technologies (GIS and other geotechnologies) and problem-based learning. Introducing GIS in the didactical process also provides learners with a spatial thinking development.

In addition to traditional teaching resources (video lectures, texts, problem solving activities), MINERVA MOOC is aimed at fostering the creation of learning communities. Therefore, it

focuses on interaction among students, professors and teaching assistants, providing immediate feedback to quick quizzes and assignments.

The 3 parts of Minerva project.

More specifically, the three main actions of the MINERVA Project have been achieved with 3 steps. Firstly, learning defines the learning needs of the students with a detailed comparison between the job market needs at a European level and the academic profiles related to Cultural Heritage. Secondly, the thought process proposes a holistic approach linking the Humanities to the Geosciences in order to enhance spatial thinking. A new teaching resource is designed for graduate and postgraduate students, adjusted to a personalized learning approach. The use of spatial tools, such as GIS and Remote Sensing aims to enhance the disciplines of Cultural Heritage, namely History, Archaeology, Anthropology and Cultural Management. Thirdly, implementation activates innovative teaching methods and resources in a structured course, providing a flexible and dynamic learning experience, specifically designed to provide Massive Open Online Courses (MOOC).

The Output IO3 describes the MOOC architectural structure and intends to satisfy several academic and professional needs especially due to their flexibility features and cross-sectoral character.

1.1 Introduction

For the use of a MOOC and its content in a relevant 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 teaching/learning approaches as well as related to university curricula and life-long learning programs. In fact, the challenge lays on the pedagogical content, which needs a different process. On the one hand, tackling the knowledge of geoscience and on the other hand using spatial software as an interdisciplinary tool for teaching CH.

This process is expressed by the well-known question: “how can teachers of CH benefit from GIS in order to enhance their student learning? And “how can spatial knowledge and understanding be used to solve problems in CH?”.

The role of GIS as an enabling technology in teaching CH, can follow two complementary approaches. Namely, we can use the powers of GIS to teach CH and GIS can help us understand our world (both the natural and man-made) which is the essence of the MOOC content in CH.

This report is aimed to design a framework of teaching GIS in CH as a tool to invigorate instruction and provide innovative content delivery in CH teaching as well as in using them as a pretense to increase student’s spatial perception and reasoning in a MOOC environment.

In other words, the first chapter will be focused on an overview on MOOC platforms used in education as well as the tools provided as pedagogical approaches.

The second chapter, after reviewing the basic pedagogic components in the MINERVA MOOC environment, presents the teaching and learning strategy in CH education. More specifically, it is devoted to explaining the architectural structure and the pedagogical content as well as exploring their value in facilitating student’s development of spatial thinking in CH in cognitive process terms. The third chapter will discuss the assessment of the learning system applied by MINERVA MOOC. Finally, the last chapter focuses on the criteria used for the MOOC evaluation.

In conclusion, although using GIS in CH teaching does not constitute an innovation, nevertheless if approached as a cognitive object and as well as an object of spatial knowledge it represents a

viable and an optimum methodology in teaching and learning in CH. That is, teaching GIS can create a positive effect on the development of spatial thinking, reasoning and interpreting.

1.2 A review of state of art of MOOC learning

Massive open online courses (MOOCs) show the current growth of open education resources and services, which could be used to solve some higher education requirements without disrupting the ecosystem. They open up chances for new pedagogies. MOOC approach is not new; with consideration that Learning Management Systems (LMSs) already allow this type of education but for a limited number of students. This means that the openness feature of MOOC approach is not fully utilized in LMSs. Currently, several universities around the world are offering courses in the form of MOOC. Also, they mentioned that expanding their reach is one side, whereas building the brand is another. It is essential that some universities are investing in MOOCs that will lead to innovations in teaching and learning.

Massive Online Open Course (MOOC) is considered as a strong competitor for the next availability of educational tools and has entered the field of higher education around the world. 2012 was a year of speedy era for education with the beginning of MOOCs to be used and learned for free in the world. It is commonly accepted and preferred because it has several advantages like large scale, no restrictions for the time and place, open free in which it can deliver a new knowledge acquisition approach for learners. In line with this, through investigating the utilization of MOOCs in some continents such as Asia, Europe and USA, it appeared that MOOC had been integrated into local curricula through the Learning Management System (LMS).

Massive open online courses (MOOCs) have attracted a great deal of interest in educational institutions. MOOCs anticipate leading the new revolution of technology-enhanced learning (TEL), by providing new opportunities to a massive number of learners to attend free online courses from anywhere all over the world (Liyaganawardena et al., 2013a). Over the last few years, the MOOCs phenomenon has become widely acknowledged as crucial for freely accessible high quality courses provided by international institutes for informal as well as formal education (Brown, 2013). In recent years, topics around MOOCs have been widely discussed across a range of academic publications from different theoretical and practical perspectives, including numerous implementations and design concepts of MOOCs.

Since research in MOOCs is still an emerging field, we found only one systematic study of the published literature of MOOCs from 2008-2012, done by Liyanaganawardena et al. (2013b). The study provides a quantitative analysis of 45 peer reviewed studies and provides a general discussion based on a categorization into eight dimensions, namely introductory, concept, case studies, educational theory, technology, participant focused, provider focused, and other.

Finally, there is no doubt that MOOC offers a course platform and student enrollment for a quick expansion. Engaging instructors, students, topics and courses has allowed MOOC to become the major topic in higher education. In the US, Canada and Europe. MOOCs and other initiatives in online courses had taken a middle phase in academic teaching.

1.2.1 Different Type of MOOCs

MOOCs share a common goal of bringing together large numbers of learners in a common environment for a course delivered as a set of online lessons. However, not all MOOCs are presented in the same manner, and they often differ in terms of their primary instructional strategy or learning design. Some MOOCs use a traditional lecture format but substitute video lectures for the face-to-face lecture components of a course, and provide automated exercises and quizzes, along with opportunities to interact with fellow students — and with the course

instructors — using discussion boards or chat functions. This style of MOOC has been referred to as an xMOOC and is characterized by the offerings from MOOC providers such as Coursera and Udacity and their university partners. These MOOCs tend to use custom-designed technical platforms, scheduled learning events and proprietary learning resources. They are intended for large-scale course delivery.

Another model of design — termed cMOOC — uses constructivist or connectivist pedagogies (Siemens, 2008), wherein learners are encouraged to build their own knowledge through social learning processes within flexible timeframes and guided by course instructors, and often using OER. It has been argued that the pedagogy of xMOOCs is better suited to learning domain knowledge that can be mastered through repetitive practice, whereas cMOOCs may be more effective for allowing learners to acquire higher-order creative skills (Bates, 2012).

There are also hybrid design models, such as those used by MIT and Harvard, that use the edX open-source technical platform. edX combines many of the key features of an xMOOC course delivery format and uses OER.

The European Union (EU) has project-based MOOCs, or pMOOCs (Open Learning Design Studio, 2012), and Canada offers LOOCs (BCcampus, 2013), local open online courses that aim to attract large numbers of students to a course structured around locally relevant subjects.

The MOOC environment will be discussed in the next section.

1.2.2 The MOOC environment

The emergence of MOOC as a technology of course delivery has changed the landscape of distance education. In addition to that, Toha examined the possibility of integrating MOOC as part of Universitas Terbuka, known as UT learning management system, into Indonesia Open University systems, as an alternative mode of delivery for UT degree programs. The author used Moodle as LMS for this integration. The use of Moodle as LMS for UT online tutorial made the students to have synchronous or asynchronous communication with their tutors. Furthermore, Azhan and colleagues described a framework called ArmadaNet for a multi-institution collaborative MOOC platform. The authors choose Moodle LMS as the web platform to support this multi-institution MOOC collaboration. The development of ArmadaNet as the model for the collaboration is based on a hub that connects and displays courses hosted in the MOOC.

Moreover, Russell and colleagues mentioned that MOOCs have two essential differences from other educational technology: (1) MOOCs are available anywhere, anytime to let students learn directly and with an extensive variety of conditions. (2) Successful MOOCs enable communication between student's activities and that helps in solving problems, answering questions, adding resources to the course and supporting other student's activities.

In principle, Gore denoted MOOC “as Massive”: in registration for any course, the enrolment in some courses exceeded 100,000 students. “Open”: means open registration. “Online”: with no need for face-to-face attendance's participants and “Course” means the concept of educational materials prepared to serve the learning process.

The definition: MOOC is an online didactic activity in which a topic is usually presented in the most condensed and informative form possible. The duration of the MOOC, which includes all the activities that the learner must complete in the course, should not exceed two hours. As part of a more comprehensive course, the individual Micromoooc can also be a completely stand-alone learning unit. Participants receive a certificate for successfully completing a MOOC, but can also be rewarded with microcredits, which they then combine. For each MOOC, 1–3 learning objectives (ILOs) that describe what students should know or be able to do at the end

of the course need to be accurately defined. Participants should in this way be aware of their previous lack of knowledge or competences in the field of the MOOC.

The structure: A **MOOC** should not contain more than 10 activities. Each one must be short: for example, five slides maximum for a PowerPoint presentation; the videos should last between 2–5 minutes. The title of the course should be as short and eye-catching as possible. The same applies to course summaries that should be maximum 10 lines and present the topic of the course, its goals and length. Estimated duration of activity should be provided for each activity.

MOOC is composed of different activities: Text documents, multimedia documents (videos, photos, PowerPoint documents, Google Docs, H5P) or questions. Each element should also have a specific goal so that the module is not unnecessarily overloaded. It is advisable not to exceed the limit of 10 elements. The elements of micromoooc can also be used independently.

In sum, the **recommended structure** for a **MOOC** is document/video → activity → video → document → activity → activity → video → document → activity → activity → course worksheet.

Important elements of a **MOOC** are also cover and teaser videos. The cover should be well integrated with the background images (pattern, solid color, etc.). The teaser video should be 1–2 minutes long and provide all the necessary information about the topic, targeted audience, speaker(s) (presenters) and learning objectives. Special care should be devoted to the preparation of these introductory pages. The suggested format could consist of the title (informative, short and attractive; up to 10 words), the abstract/summary (up to 10 lines, could be in a form of bullet points and contains the overview of the topic to be dealt with in the MOOC), the intended learning outcomes (as bullet points), the connections (links) with other similar MOOCs, the title photo or graphics (integrated into background) to visually present the contents of the MOOC and the introductory video (could be as a cartoon, or with "actor/s", but in any case should whet the appetite and catch the attention of potential participants; too long monologues or static shots are to be avoided).

The elements: The elements for MOOCs can be created using various online (H5P, Google Classroom, etc.) and offline authoring tools (iSpring Suite, Articulate 360, Captivate, etc.) and can sometimes already be a part of the learning management system, as is the case of Moodle and Open EdX.

The need to have as many interactive activities as possible could not be overstressed. Most of the tools used for construction of MOOCs already contain possibilities to incorporate interactions between the participants (for example: an assignment accomplished by one participant is forwarded to another one anonymously that has a new task of evaluating his/her peer and thus providing feedback to other participants -and vice versa, of course-). Furthermore, additional interactive approaches could be set up in the way of forums, chats, question-and-answer pages etc. as well as by the interactions (possibly to a lesser degree) with a moderator. Setting a dictionary of acronyms, special terms etc, as well as devising criteria (rubrics) to evaluate performance of participants in each activity, also, need to be considered. Moreover, certificates should be issued at the end of the participation. Setting dates of starting a MOOC as well as considering what time will be allowed for participants to complete the activities (although MOOC is an asynchronous way of learning, there is still some synchronicity needed) is another issue to take into account. Finally, as with all intellectual outputs, careful consideration must be given to who the authors of the MOOC are and in what order they should be listed.

Constructing a MOOC is a cyclic process which requires production of an initial test version which is offered (internally) to a limited (selected) set of participants (approximately 10) that already have some experience with making and using MOOC. They need also to be willing to provide in-detail feedback and opinion on the initial MOOC thus enabling the authors to improve their product. The second (improved) version could be offered to a bit broader audience, but is typically still limited to the selected participants (maybe from other partner institutions inside our project consortium) providing further feedback and (hopefully) ideas for final polishing of the product. MOOC thus obtained is ready to be deployed on a broad base via selected (appropriate) MOOC provider, either commercial, academic or self-produced dedicated web page.

1.2.3 MOOC VS MOODLE

Moodle (**Modular Object-Oriented Dynamic Learning Environment**) is an e-learning platform used throughout the world. Universities, communities, schools and teachers use it to communicate and transmit information to their educational communities. Developed by Martin Dougiamas is a platform with satisfactory technological characteristics for teaching, attracting users and developing collaborative work. The great success of this platform due to the fact that it is an open source system, providing programmers the opportunity to make new contributions, with new applications, making it one of the most widely used in courses distance. It seems to us that the integration of such platforms deserves special attention and should be included in educational settings, despite all the limitations and lack of existing at the different levels, such as difficulty in accessing the platform, because the connections are very slow or that the servers cannot manage the information when there are many users, or because there is no availability of computers with Internet connection.

Moodle is composed of a simple interface that looks more like a portal of information. In general, the pages of the courses are divided into three columns that can be customized by the teacher or the course, adding elements such as: calendar, online users, list of activities, among others. These elements are arranged in columns to the right and left of the screen the user can be moved from one place to another. In the center column, we find a set of options that may be the result of the class through a list of topics numbered or dated weekly or, areas to group content or similar activities. In the center column of the courses that use Moodle as a virtual environment, there are generally living areas, for the record of course-related news, discussion forums, content areas to enter text, images and presentations on the theme, activities areas, to direct the tasks to be performed or delivered to the teacher or the central column, is the place where resources and activities are available. Through this environment, we can create various activities and use a set of tools that can be used according to each educational objective.

In the current Moodle in SQU, courses could be developed in it. Each course has 13 to 15 weeks duration for the whole semester including materials (lectures notes), assignments, activities and exams. The student should complete the entire course to get the credit hours in a blended mode. Conversely, if we integrate MOOCs in Moodle, each course might be divided into units or parts, the relationship within course parts is considered as low coupling. Each unit will take a specific duration between 3–4 weeks and consists of materials, assessments, exams. The relationship within unit parts are designed in a spiral way.

The Moodle environment is shown in Fig. 5. Students from different universities will enroll in the courses via Moodle interface with their university ID and password.

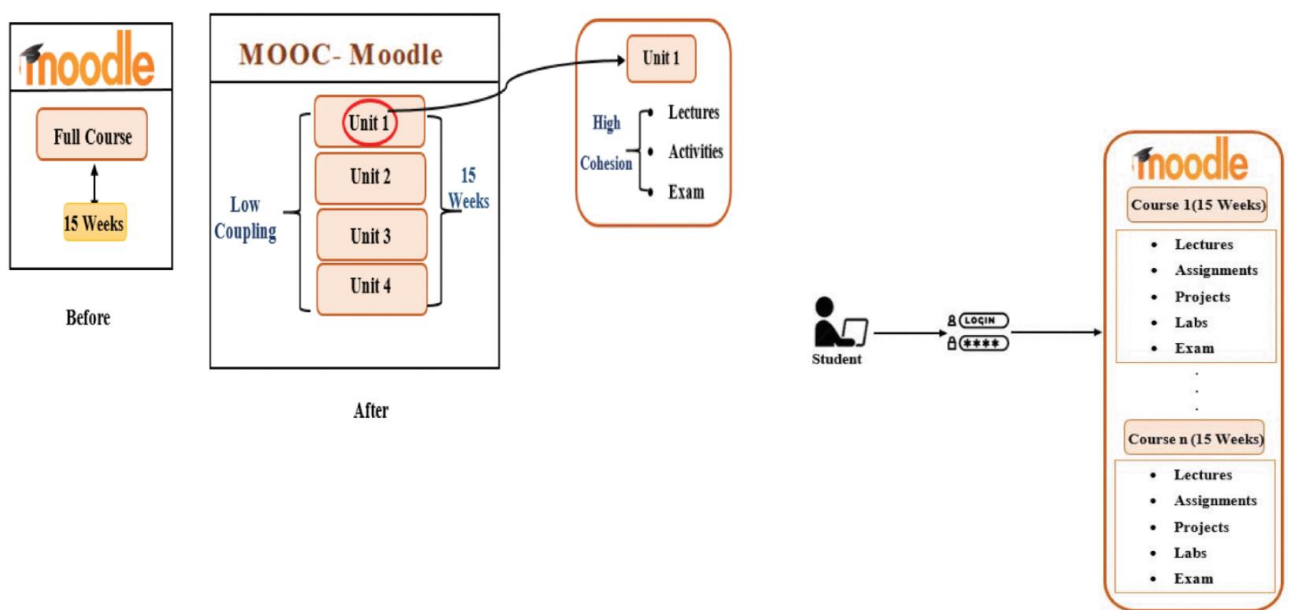


Fig. 4-5. Moodle environment (1 Zuhour Al-Khanjari Iman Al-Kindi, "Integrating MOOC with Open Source Moodle: The New Direction of Learning")

2. Minerva MOOC design

The third phase of this project, as a physical product, is to create the possibility of adapting MOOC to support the designed didactic material of learning and teaching process in that it promotes and improves courses' content and hosts online learning activities by using Moodle for the purpose of CH. Also, to highlight new pedagogical approaches when integrating MOOCs in the Moodle E-learning environment will allow us to explore new learning models and innovative practices in teaching and learning.

The conceptual framework of Minerva teaching and learning strategy is presented in the following table.

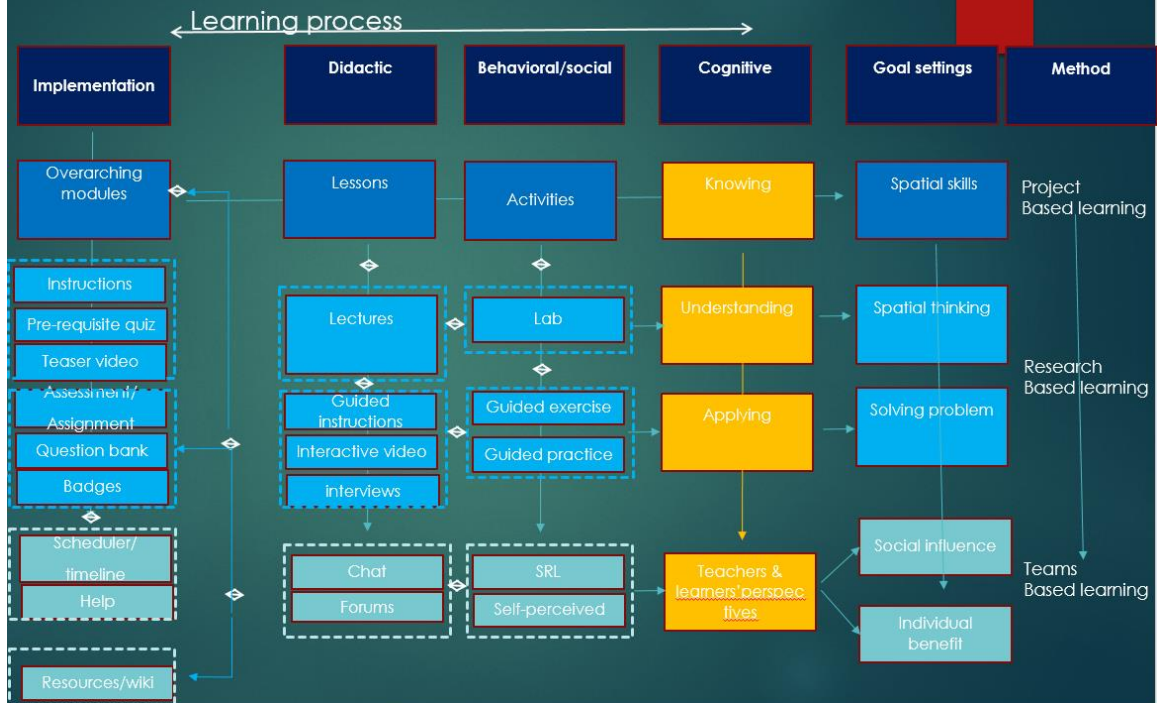







Fig 6. Minerva MOOC design



2.1 Implementation

The MOOC contains different pedagogical methods in order to enhance students and teachers combining two different learning components thus, the CH knowledge and spatial skills. Geotechnologies and specifically GIS, serve as a vehicle in order to design the didactic material in teaching and learning CH. Different case studies embedded the content of lessons as well as the overarching modules and a bank of questions is available in order to evaluate the didactic process.

More specifically, the framework that describes the content is:

- a) **Modular description:** it provides the schedule of lessons content of each 'Overarching module'
- b)  **Video lecture:** to describe the theoretical part of a topic
- c)  **Teaser video:** video A trailer that provides more information about the module content in order to create anticipation, spread awareness, or hype up about the topic.
- d)  **Interviews:** This activity is an interactive, introductory, teacher-colleague activity to open the discussion about asking questions and defining problems.
- e)  **Interactive video:** it is a form of digital video that supports user interaction. Interactive videos provide the viewer the ability to click, on a desktop, or touch on mobile devices within the video for an action to occur.
- f)  **Guided practice** (to implement a "flipped classroom"): Guided practice is an interactive exercise between the teacher and students. After the teacher introduces new learning, it begins

the student practice process, The teacher engage students in a similar task simultaneous by providing simple data

- g)  **Guided exercise:** A process-oriented guided inquiry learning (POGIL) activity that develops, implements, complements, summarizes, and allows for application of the material contained in the previously viewed lecture and students will complete later.
- h)  **Guided-instructions:** Step-by-step instructions in software operation for case studies/exercises.
- i) **QUIZZ** **Quizzes:** with practicing quizzes, students can do critical thinking, and get into a habit of innovative learning. These quizzes integrate the game mechanics into the learning process. A Pre-training questionnaire is provided in order to classify student’s knowledgein an overarching module (individual activity).

The MINERVA MOOC interface is offered in the national partner’s languages. The content of the material is provided in English. Moreover, all didactic material is subtitled in the partner’s national language via YOUTUBE through MINERVA channel. The possibilities of a MOODLE environment are activating and different tools are offered in order to facilitate the interaction.

In fact, the pedagogic aims of this whole-group hands-on experience is conceived to familiarize 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. Such experiential learning involving concrete experience, observation and experimentation is a feature of training provision (Kolb, 1984).

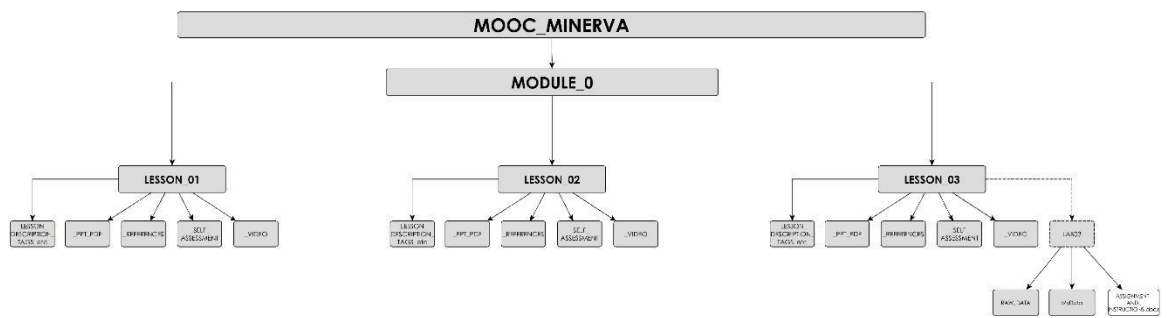


Fig. 7. The organization of MINERVA MOOC

2.1.1 The Overarching Modules

The MOOC contains five (5) overarching modules highlighting GIS process, that is:

- a) Introduction, b) data acquisition, c) data management, d) data analysis and c) data visualization.**

Each overarching module develops the topic that has a specific duration 3–4 weeks. We can consider each overarching module as MOOC or mini-MOOC that consists of lectures, activities, assignments and exams. Moreover, each overarching module has a separate topic, for instance, the topic of overarching module 1 is related to overarching module 2 and so on, but it could be worked separately. It depends on the instructor, if he/she wants his/her students to take the

course by overarching modules or use the normal way to take the whole course at one time. By this way, the researchers successfully implement the concept of MOOC in the current E-learning system in terms of MOOC styles and open the course for a larger number of students that Moodle can supply. MOOCs are not going to replace face-to-face learning anytime soon for SQU students. But MOOC content will be as part of 'flipped classrooms'. If this is done well, it could be an example of how online educational technology improves the on-campus experience rather than replaces it.

Overall, the researchers do not have to build the whole Moodle environment, which is very time-consuming. The overarching modules contain three lessons, except the overarching module three (3) namely "Data analysis" that contains four (4) lessons. The table below shows the content of overarching modules as well as the pedagogy method applied.

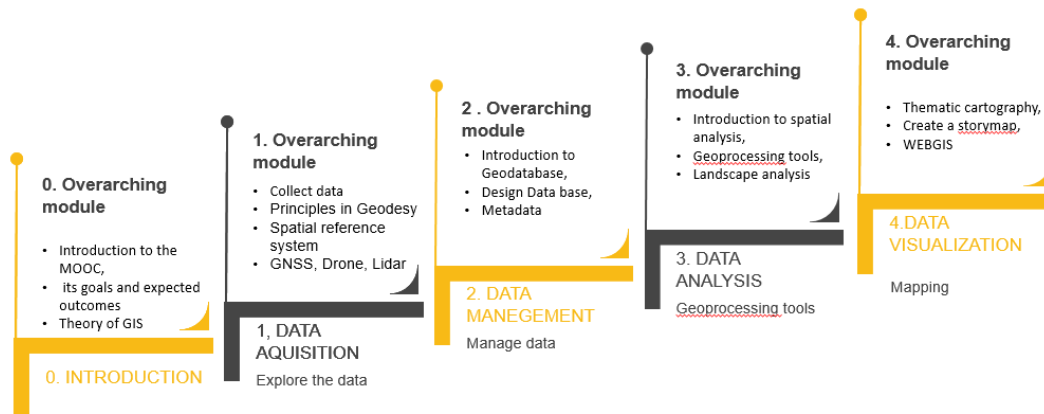


Fig. 8. Overarching modules & Lesson content

An overarching module allows a lecturer to create conditional pathways through material. It consists of a number of activities ending with a questionnaire and a number of possible answers. Depending on the student's choice of answer they either progress to the next lesson or are taken back to a previous one. When students answer a question, they are redirected to whatever lesson you'd propose them to see next based on their answer. It can be a helpful tool for practicing material, studying, and testing.

2.1.2 DIDACTIC PROCESS: Lessons' Content

Lessons' content is designed with the aim to facilitate teaching and learning activities into two axes. The first one, as a whole didactic material for teachers and students. The second one, as a micro-MOOC that can also be a completely stand-alone learning overarching module with planned outcomes of the lessons in order to achieve a learning process such as behavioral, social, cognitive. All the outcomes will be according to the settled goals, namely, spatial skills, spatial thinking, and solving problems. These processes will be discussed in the next section.

The lessons' content is designed according to main components of Geotechnologies in the purpose to facilitate the teacher to develop an appropriate topic for each overarching module or formulate a micro-MOOC for it. to design a MOOC for teaching material in CH of the university lecturers and a MOOC having an engaging and active learning approach, to describe the pedagogical features of lessons and how to avoid common overlaps or gaps and finally to describe the principles of each lesson and issues connected to the overarching modules

Learning activities for each overarching module are designed in the purpose to listen and try to comprehend the theory part via video lecture (individual activity) before the training, to accomplish assignments such as guided practice, guided exercises and guided instructions and to fill-in questionnaire per module (individually).

The description of the basic or advanced tools according to the didactic and cognitive processes is displayed in the following table.

More specifically, the syllabus provided figures in the below table.

The image shows a screenshot of a course syllabus interface. On the left is a vertical sidebar menu with the following items: Participants, Badges, Grades, General, Introduction (highlighted with a yellow border), Data Acquisition, Data Management, Data Analysis, Data Visualization, LAB-BOX, and Home. The main content area on the right displays the following lessons and topics:

- Lesson 1.1 Introduction to data acquisition**
 - Data sources
 - Primary/Secondary data
 - Spatial data
 - Raster/Vector Data Models
 - Scale and resolution
 - Topology
 - Attribute
 - Metadata
- Lesson 1.2 Geodesy - georeferencing tools**
 - Introductory principles in Geodesy (only with bibliographic references)
 - Georeferencing tools
 - Georeferencing
 - Spatial reference system
 - GNSS (Global Navigation Satellite Systems)
- Lesson 1.3 Introduction, principles and applications to UAV, Lidar, 3D modeling and laser scanning**

Introduction to unmanned aerial vehicle (drone), aerial and terrestrial Lidar, and 3D data

 - Drone (UAV)
 - Lidar
 - Laser scanning
- Lesson 1.4 Principles and applications of remote sensing. The Copernicus Earth Programme**
 - Remote sensing data
 - Principles and applications of remote sensing for triggering mapping representations.
 - The Copernicus Earth Programme
- Case study 1 - Mapping natural and human-made borders**

Geotechnologies for Cultural Heritage

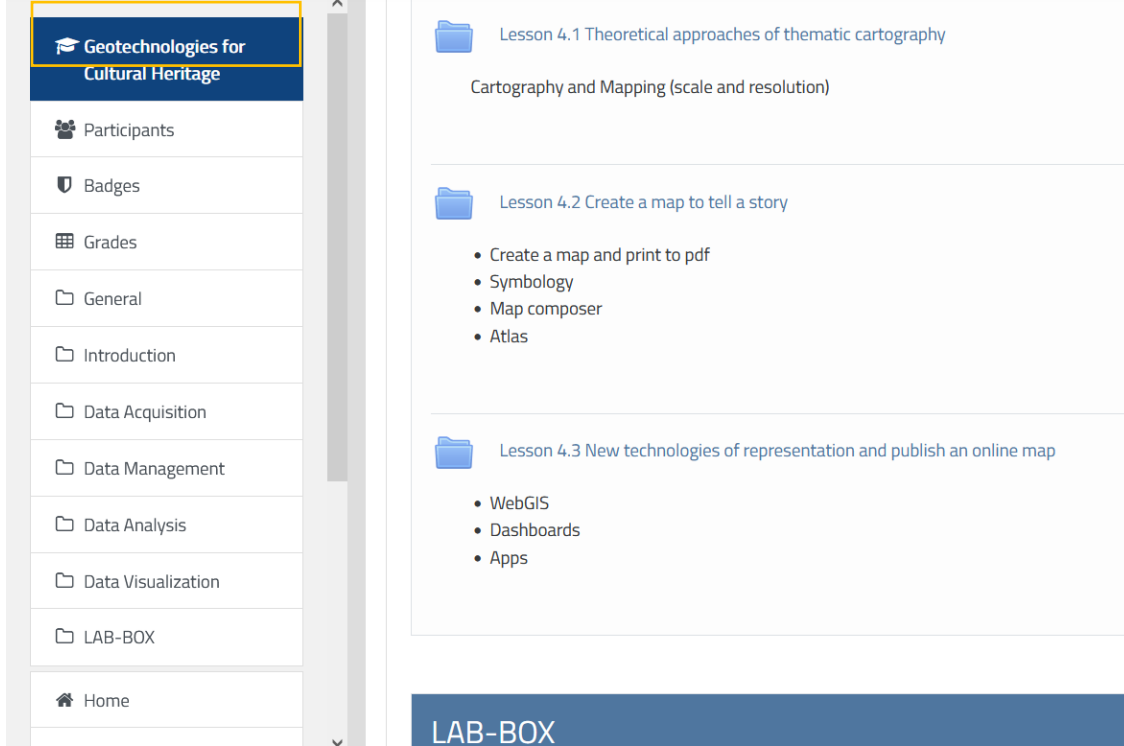
- Participants
- Badges
- Grades
- General
- Introduction
- Data Acquisition**
- Data Management
- Data Analysis
- Data Visualization
- LAB-BOX
- Home

- Lesson 2.1 Introduction to Geodatabases
 - Geodatabase, design, relationships, formats.
 - Metadata
- Lesson 2.2 Design of geodatabase for CH
 - Attribute table
 - Select by attribute, by location
 - dbf, csv
 - join, relate tables
 - Spatialite
- Lesson 2.3 Create metadata for CH
 - Metadata tools
- Greek Case Study: Athens Western Hills - Explore, manage a

Geotechnologies for Cultural Heritage

- Participants
- Badges
- Grades
- General
- Introduction
- Data Acquisition
- Data Management
- Data Analysis
- Data Visualization
- LAB-BOX
- Home

- Lesson 3.1 Introduction to spatial analysis
 - Introduction (spatial analysis and daily life).
 - Background.
 - Concept.
 - Typology (measurement, **Lesson 3.3 Solving a spatial / geographical problem**)
- Lesson 3.2 Introduction
 - Contents**
 - The pre-historian example of Karystos (Greece). A problem based exercise
 - Introduction & interview
 - Explore the data
 - Organize the data
 - Criteria
 - Step by step workflow (buffer, union, select, clip)
 - Lesson 3.4 GIS for landscape analysis
 - Introduction
 - Definition of a landscape
 - Distance analysis (Buffer, Euclidean distance, Anisotropic distance)
 - Intervisibility analysis (DEM, Sources, Targets, Intervisibility network, Viewshed)
 - Terrain analysis (DEM, Slope, Aspect, Curvature, Relief classification)
 - Case study



2.1.3 BEHAVIORAL/SOCIAL PROCESS: Pedagogical tools

Many tools available in the MOODLE environment are activated in the Minerva project in order to enhance behavioral/social cognitive processes, according to the relevant methods to achieve the respective goals.

More specifically, Teams-based learning is activated through chats and forums in order to enhance social influence and individual benefit such as self-regulated learning and self-perception of teachers and learners' achievements.

1. CHAT

The Chat module allows participants to have a real-time synchronous discussion. This is a useful way to get a different understanding of each other and of the topic being discussed. The mode of using a chat room is quite different from typical internet forums. Chat contains a number of features for managing and reviewing chat discussions.

2. FORUMS

Forums are used for asynchronous online discussion. By subscribing to a forum, participants receive copies of each new post by email. Teachers can impose subscription on everyone if they want to, and in this way can use a forum to contact all students on a course. They allow students and teachers to post comments in a central place to simulate (and stimulate) discussion. All Moodle courses automatically come with a News forum which cannot be removed, and all course participants will receive email whenever anything is added to that particular forum. However, you can add new forums as well.

3. GLOSSARY

The Glossary activity allows participants to create and maintain a list of terms and definitions, as in a dictionary. It can be used to build an annotated list of useful websites or FAQs. The

definitions can be searched or browsed in many different formats, and can be linked from other places on the site.

4. DATABASE

The Database module allows the lecturer and/or students to build, display and search a bank of record entries about a topic. The format and structure of these entries can include images, files, URLs, numbers and text amongst other things. Although the database currently has issues exporting data for different modules, it is sometimes convenient to store and share data with all the participants. Database consists of multiple fields, which you need to create. You also set each database to decide how many entries each participant must write in order to view other entries, minimum and maximum entries one is allowed, and so on.

5. QUESTION BANK

The questionnaire module in Moodle allows users to create a survey or questionnaire for students to fill out, for instance, a module evaluation or a reading response survey.

6. SCHEDULER

Scheduler is a Moodle Activity that allows the course instructor to post available meeting times and then have students sign up for the slot that best suits them. This is useful for required students-teacher meetings, such as advisory days, or simply for optional office hours.

7. ASSIGNMENTS

Assignments allow students to submit work online, including uploading any file type (Word document, Powerpoint, video clip etc.). Lecturers can grade and give feedback.

8. QUIZ

The Quiz module allows the lecturer to design and set quiz tests, and includes a range of question types and reporting options. Moodle Quizzes are a great resource for every professor. Electronic quizzes can do many things that paper quizzes just can't. You can create different question types, randomly generate quizzes from pools of questions, allow students to retake quizzes multiple times, and have the computer score it all. These features open up a world of possibilities that just aren't practical with paper-based testing.

Moodle quizzes have two components: the quiz body and the question pools. The body is the final quiz that a student will see, after all the randomizing and question-picking--it is the "container" for the various questions pulled from the question pools. One can define rules for how the body pulls from the pools: for example, you might create three question pools, one for each chapter that you are testing, and tell the quiz body to pull five questions from the first chapter, two questions from the second chapter, and three from the third chapter. Pools can be reused, shared between classes, and moved between systems.

2.1.4 COGNITIVE PROCESS

This section will describe the role of effective cognitive processes that enhance the learning methods according to the respective goals. That is, in teaching CH, i.e. instructing students in the appropriate subject matter, in the necessary skills and in applying them to solve CH problems, the process should be focused on "learning the concepts and vocabulary of Geotechnologies (knowing) so they may begin to think about what they mean (understanding) and apply to real problems (applying)" (NAEP, 1994). In Geography terms, that is, geography skills, subject matter and perspectives correspond to the processes of knowing, understanding and applying.

2.1.4.1 The Process of Knowing

This process in spatial terms is expressed by two questions: “What is it?” and “Where is it?”. That is, through instruction CH students should be able to participate in two related functions with respect to managing/processing geographic information: observing and recalling. In other words, CH students are expected to be able through observing and recalling to acquire information, to arrange and organize them and finally to represent them. And in doing so, to be able to answer the fundamental questions of the knowing process mentioned previously, as a result of having the necessary spatial skills.

2.1.4.2 The Process of Understanding

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 them. That, of course, involves the teaching of all the analytical concepts and principles that provide them with the ability to comprehend, to see connections between diverse pieces of geographic information and to use that information to explain patterns and processes in space. In other words, to understand the subject matter of geography.

2.4.1.3 The Process of Applying

This process is expressed by the well-known question: “How can knowledge and understanding be used to solve spatial problems?”. This process involves forming problem-solving models, formulating solutions to problems and in general applying geographic knowledge in a practical manner to real life situations that influence the world around us. As a result, students have to comprehend and deal with sophisticated contemporary issues by knowing their skills and understanding their subject matter to solve everyday problems. And in doing so, to interpret the world through their own perspectives.

This process activates the respective goals that will be discussed in the following section.

2.5 GOAL SETTINGS

All the above processes are interrelated in a horizontal manner and focus on helping students achieve skills and knowledge in order to enhance critical thinking such as spatial skills, spatial thinking and perspectives.

2.5.1 Spatial Skills

The study of CH using geotechnologies requires the use of numerous spatial tools and techniques lumped into the term geographic skills. They are central to Geography’s distinctive approach to knowing patterns, processes and relationships in geographic space. In this process CH practitioners should be able to ask geographic questions, to acquire spatial information and to organize them. Because geography is distinguished by the kinds of questions it asks –the “where” and “why there”-, the means to acquire such spatial information and the ways to organize them.

2.5.2 Spatial thinking

As a result, it is important for teaching and learning CH that tools and techniques should be available. First, in asking geographic questions related to why things are where they are. Second, in acquiring information by locating, observing and systematically recording places, people and environments, given that CH information relates to the process of knowing about location, the physical and human characteristics as well as the activities on those locations. Third, in

organizing and displaying information in ways that help the analysis and the applications, since geographic information once collected needs to be processed.

In sum, what is put forward is that the tools and techniques, mentioned here as spatial skills, allow teachers and students in CH to derive spatial knowledge. That is, to know the world around them by participating in the process of **knowing**.

Up to this point, in discussing spatial skills no mention was made of those related to analyzing and answering CH questions. The reason is obvious. Namely, analyzing and answering geographic information involves understanding patterns, relationships and connections, a step forward from just knowing about facts, their organization and representation, for they lead into synthesizing, drawing inferences, identifying trends, relationships and sequences. That is, all those aspects that constitute what is termed here the process of understanding, which basically reflect the subject matter of CH and will be the focus of the next section.

2.5.3 CH Perspectives: solving problem

A CH perspective is a collective (geographers') point of view interpreting the meaning of patterns, processes and relationships which involve people, places and environments over time. That is, a geographic perspective is simply a lens through which geographers look at the world. Although most geographers think of a geographic perspective as a frame of reference for **knowing** the world (by determining the geographers' skills) and for **understanding** the surface of the earth (by specifying their subject matter), nevertheless a geographic perspective is much more than that. More specifically, it involves the ways that knowledge and understanding can be used to solve problems or the process of **applying**. That is, the spatial dimension of human experience on earth, which brings people, places and environment under the lens of Geotechnology, provides the means for solving spatial problems by activity participating in the process of applying in the CH field.

2.5.4 Instead of epilogue: Questions Answered by GIS

The approaches related to what GIS are and what they can accomplish (processing, analysis and planning) are considered by most as independent and conflicting endeavors. However, such an approach is clearly scientifically shallow and logically unsound. Certainly GIS are information systems but they are not exclusively manifested as such. The same is true as to their role as analytic or planning tools. Clearly GIS are planning but not only planning tools. They are an excellent spatial analysis methodology but they are not only that. Someone can certainly design excellent maps using GIS but that does not exclude somebody else to execute a very complicated spatial analysis without them. In sum, scientific reasoning, application results and common sense dictate that the three GIS approaches, mentioned previously, are scientific fields which, having as common background the spatial dimension, are closely interrelated, complementary and all of them are separate components of an integrated spatial approach.

2.6 LEARNING METHODS

The previous description shows that the MOOC environment requires different approaches in teaching and learning through didactic, behavioral/social and cognitive processes according to the respective goals. That is, Project Based Learning, Research on Project-Based learning and Teams Based-Learning, leading students to Self-Regulated Learning and Self-Perceived.

According to the basic self-regulation strategies that all students need to be able to use: goal-setting, self-monitoring, effective use of self-instructions and self-reinforcement.

Self-perceived overall competence is defined as a personal characteristic that reflects one's global expectation or belief in his/her ability to accomplish tasks (Eccles and Gootman, 2002,

Lerner et al., 2005, Schunk and Pajares, 2005). Lerner et al. (2005) demonstrated the importance of self-perceived overall competence in positive youth development.

2.6.1 Project Based

Project Based learning (PBL) is an active student-centered form of instruction which is characterized by students' autonomy, constructive investigations, goal-setting, collaboration, communication and reflection within real-world practices. For instance, it has been explored in various contexts and in different phases of Minerva training, in higher education. The case studies were based on a quasi-experimental pretest–posttest design with some baseline equivalence established with a random allocation of participants to control experimental groups, and as a result, a causal link between PBL instruction and positive student outcomes can be established with certainty.

Modern digital technology, group processes of high quality, teachers' ability to effectively scaffold students' learning and provide guidance and support, the balance between didactic instruction with in-depth inquiry methods and well-aligned assessment have been identified. These results are aligned with the literature as facilitating factors in the implementation of PBL.

2.6.2 Research Based Learning

Inquiry-based learning has been promoted as a student-centered approach that can strengthen the links between teaching and research, thus, Doing with Understanding means Lessons from Research on Problem- and Project-Based Learning.

The potential of inquiry-based learning to strengthen the teaching–research nexus by analyzing case studies, a 'structured inquiry' module, a 'guided inquiry' and an 'open inquiry' corpus of lessons. During the training, the relation between teaching and research led to a reconceptualization of inquiry-based learning.

The teaching and learning strategy provided in MINERVA MOOC, leads to linking the focus of learning of information or discovery-oriented inquiry, with the level of independence and the potential strength of the teaching–research nexus. In conclusion, if teachers are aiming for strong links between teaching and research, they should adopt an open, discovery-oriented inquiry-based learning approach. However, more structured and guided forms of inquiry can be useful to progressively develop particular inquiry skills.

2.6.3 Teams Based learning

The learning experiences of students in geotechnology in CH problem-based learning (PBL) curriculum is implemented, with an emphasis on student approaches to Knowledge construction. In other words, it focuses on a collaborative process which aims to produce new understanding or knowledge, well exceeding something that anyone alone could achieve. It is also essential that knowledge construction be based on each other's ideas and thoughts. This approach helps student learning in a PBL team in this setting. It is obvious that it is influenced by the attitudes, behaviour and learning approaches of the student members in that team. It is certain also, that it develops student's capacities in order to enhance Self-Regulated Learning and Self-Perceived.

2.6.4 Instead of epilogue

Students in a problem-based, or project-based, learning setting may not automatically adopt a collaborative learning culture. Hence, it is important for a MOOC environment to take into consideration the factors that influence student learning in their particular setting and to provide students with all the necessary tools to nurture deep learning approaches in PBL teams.

The implemented didactic material and tools support our teaching and learning strategy, integrate the influences of cognitive factors, through the proposed pathways and play a major role in overall students' both competences and skills in the subject matter.

3. Assessment of learning system

Assessment of learning is an important aspect of educational pedagogy and it is important to monitor students and to be able to know if they are really acquiring knowledge. Assessment evaluation and self-evaluation are an essential part of any kind of training. Right kind of assessment strategies help the teachers obtain right kind of feedback. One of the strategies for assessment is to deploy quizzes for formative as well as summative assessment. Hence, in the e-learning environment there is a need to design suitably the quizzes in order to accomplish an effective tool for this purpose. This chapter, first, focuses on an overview of the assessment and solution learning system, second, describes the Minerva evaluation approaches applied and finally, the e-assessment system is analyzed.

3.1 An overview

All evaluating systems increase students' self-evaluation to complete tests and after that they get constructive feedback with their weaknesses indicated and the concepts that should be prepared more, until the next test.

An overview of bibliography seems to suggest different methods for ranking the questions, helping students validate a set of questions. Authors propose a feedback system in order to calculate the difficulty of quiz questions, that once a different student answers it in the ranking process, and after that the questions will be used for other students and see the reaction of them regarding the questions. Test questions and assignments, which are included in a concrete e-test, are chosen on the basis of different principles and rules. Opinions of different authors expressed in the literature are very contradictory. Some authors consider that the test assignments must be chosen according to their type (according to the appropriate classification), and others think that they must be chosen according to their content (including relationship with the subject domain) and/or cognitive objectives of the learning process.

An overview of bibliography concerning various online solutions for the evaluation of students is mentioned. Some of them are analyzed below.

Socrative is a free student evaluation system available from any device connected to the Internet (tablet, smartphone, laptop) through web applications (Chrome, Safari, Firefox, etc.) or mobile (for iOS or Android), which allows teachers to create and distribute tests to the students with different types of questions over a designated time duration: true / false, multiple choice, short answer questions.

QuizCreator is an online test software system that allows users to build tests and surveys, and then track results. This system is composed of two applications, namely a QuizCreator desktop application in which the actual tests are built and a QuizCreator Online site in which the test is published and the results can be visible.

Easy Test Maker is an easy-to-use student assessment tool, presented in a simple and highly organized format. This application allows the creation and publication of tests online.

Kahoot and Quizizz are other applications used for quizzes. The advantages of these applications are that the teacher can establish the time for each question. In this way the

students will have limited time to answer each question. This factor may reduce the chance for cheating.

All these evaluation systems have been taken into account for the applied evaluation in the e-learning environment used in the Minerva project. For this purpose, it is necessary to examine a new index that considers the difficulty of the questions related to different levels of learning, in order to create different modular paths.

In the Minerva project an approach of ranking the questions is proposed in learning outcomes and in sensorimotor terms and it is explained in the following sections.

3.2 MINERVA assessment of learning system

According to the setting goals, teachers are confronted with a big challenge during the student learning process in an e-learning environment. On the one hand, they have to determine the conditions and material of instruction that optimize the student learning and, on the other hand, the evaluation that mentions students' learning progress. Hence, evaluation should be equitable for all students and should be in accordance with the cognitive process in a spiral manner.

One of the most important priorities of the automatic e-test assessment and organization is resource saving. Thus, examination using e-Learning environments guarantees reliability, and application of objective criteria. Several issues are evolved in using e-tests, on the one hand, teachers can check both knowledge and skills in much more domains compared to the classical form of examination and on the other hand, learners can see outcomes of their achievements and learning progress much faster compared to the time necessary for the classical way of examination. Despite the fact that contemporary information technologies provide a lot of functional and interactive possibilities, a great part of the e-Learning environment provides few types of test questions and assignments. In fact, it still constitutes an open research question for the realization of an efficient assessment system.

Elements and characteristics of each e-assessment are saved in a database named Content bank. The computer realization of each type of e-assessment requires relevant functions for each question insertion, such as the type of question, the degree, the correct answer etc.

With this objective, Minerva project applies an evaluating system in order to determine the quality and objectivity of the quiz questions. The assignments, thus case studies proposed as didactic material in each overarching module are made through quiz questions. Their difficulty level is determined by the person who carries out these questions, the teacher.

The evaluation system of learning is established first by the difficulty level of the quiz questions according to the didactic and cognitive process. This approach helps to supply the questions with increasing difficulty. In this way, it offers the student the possibility of gradual evolution. More specifically, the difficulty of the questions is based on the weight of the learning outcomes in a scale 0.5 to 6, as described in Bloom's taxonomy and thus is graded in the preparation phase of the questions. Second, it is based on the type of questions according to the sensorimotor approach. The value is on a scale 0.5 to 3. The algorithm can be applied to other sets of quiz questions.

The aim of this assessment system is to establish the quality in terms of difficulty of quiz questions by assessing the students' knowledge and their interaction with these questions in the learning management systems. Minerva assessment learning system can provide numerous applications in the educational field that help to improve the academic performance of

students, such as in applications that use digital rankings or badges to help engage, motivate and maintain student attention.

The Content bank questions are created and mentioned by the teacher. On the platform there is the possibility to create more question banks and in that way it can use all of them or a part anytime needed. After the insertion of the questions, a quiz is created on the MOODLE platform where students can enter and take the grid test whenever they want in the appropriate module. All answers to the questions are saved for future analysis. Both the answers from the users' first support for each question and the answers from the subsequent support are saved. Thus, an analysis can be made regarding the evolution of the responses of some participants over time. If some questions have a very high degree of difficulty, the participants will not answer correctly from the second / third attempt either. In addition to the answers of the questions, the final results of the users will be saved. This will allow in the second phase to re-calculate the difficulty of the questions based on their knowledge. If a user has answered more questions correctly and has only a few incorrect answers, these questions have a high level of difficulty. Also, the time spent by the user during the test is saved, so that the degree of confidence of the users in their answers is also used.

3.2.1 The Realization of learning assessment and assignment

The classical test consists of a set of test assignments and questions from a concrete subject domain, related to an assessment system and offered for solving or accomplishment of certain activities. This goal is not independent from the whole educational strategies applied by the project and the pedagogical approaches mentioned in IO2.

The Minerva project revising the needs of the specific field, according to new didactic approaches in the MOOC environment, proposes an assessment system based on Bloom' taxonomy as well as a sensorimotor approach. More specifically, test assignments provided by Minerva project reshape a spiral evaluation system using different criteria such as learning objectives, cognitive process, level of difficulty, type of questions and sensorimotor issues of the examinees.

As for questions and assignments with constructed answers (closed type), examinees select the correct answer from a set of alternative answers.

According to test theory, test questions and assignments are divided into seven groups, that is Seven Types of Quizzes that Deepen Engagement with Course Content:

- *Fill in words*: this question type provides students with a list of possible terms to fill in the blanks
- *Drag and drop images*: Images as answers will bring a **new level of instruction** and fun to different subjects
- *More than ONE correct answer*: students can choose more than one possible answers
- Only **one** option is the correct answer: A student can only select one answer option when playing the quiz.
- *Ranking the answers*: with this question type, students are assessed on higher-order thinking questions and gauge their understanding according to the learning objectives,
- *Choose ALL answers that apply*: students are encouraged to match concepts and topics they've learned with this question type.
- *Drag and drop text*: it helps students to increase their concept and practice of doing & research
- *True/false answers*: it encourages students to perceive their role in learning.

The classification based on the learning objectives of the corresponding test is widely used in test theory. Classifications of this type are often based on the taxonomy of B. Bloom, known as "Taxonomy of Learning Objectives". Bloom's categories are related to cognitive domains like: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. All cognitive domains present different categories and their subcategories providing "verbs" (scheme 1) in order to achieve the learning objectives of a specific field and underline sensorimotor strategies.

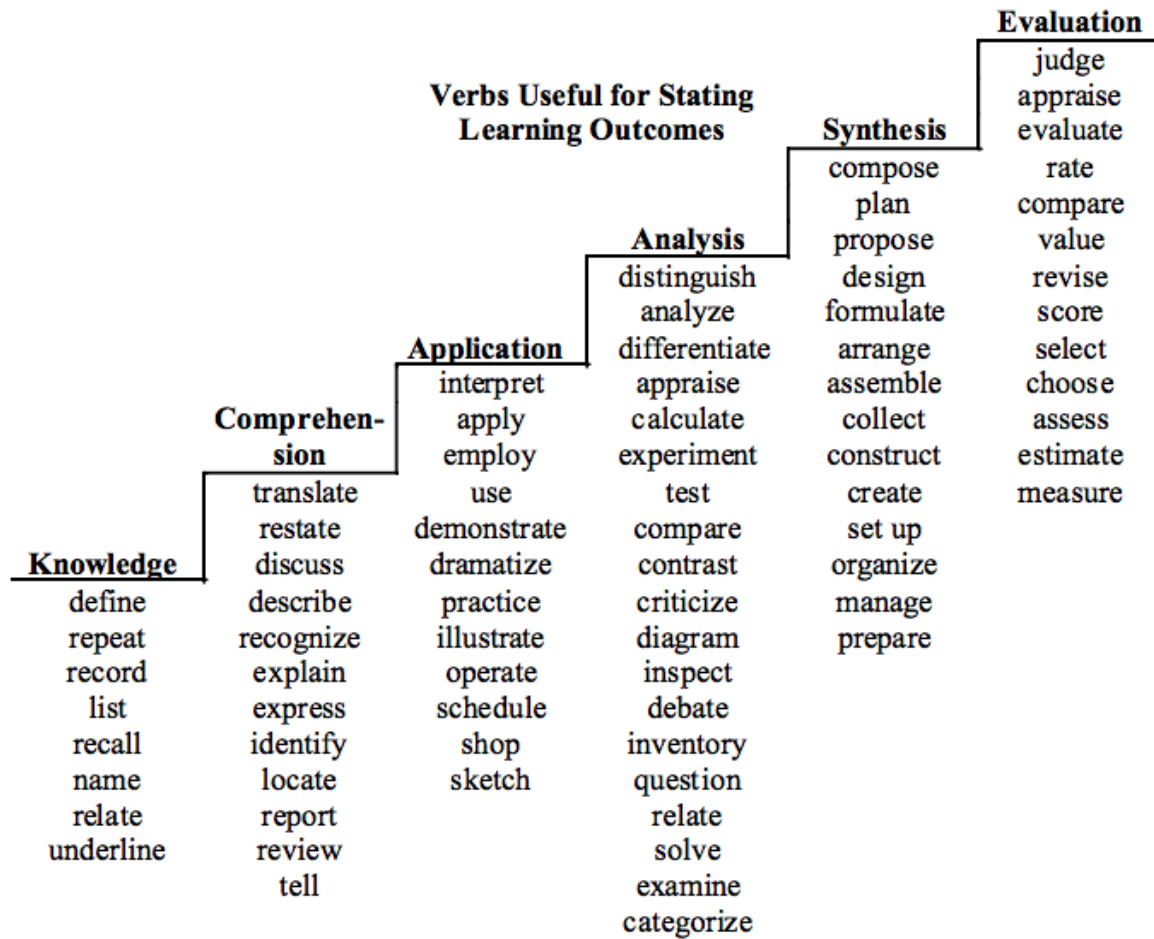


Fig 9: Bloom's Taxonomy of Educational Objectives

3.2.2 The sensorimotor approach

If understanding is required for perception, how can we learn to perceive something new, something we do not yet understand? According to the sensorimotor approach, perception involves mastery of regular sensorimotor co-variations that depend on the agent and the environment, also known as the "laws" of sensorimotor contingencies (SMCs). In this sense, perception involves enacting relevant sensorimotor skills in each situation.

This theory highlights the importance of intrinsic sensorimotor norms, in terms of the closure of sensorimotor schemes. It also explains how the equilibration of a sensorimotor organization faced with novelty or breakdowns proceeds by re-shaping pre-existing structures in coupling with dynamical regularities of the world. This way learning to perceive is guided by the equilibration of emerging forms of skillful coping with the world. The compatibility between Piaget's theory and the sensorimotor approach applies to the Minerva assessment learning by providing a dynamical formalization of equilibration giving an explicit tool of sensorimotor learning and, by extension, of how we learn to perceive. The sensorimotor approach to

perceptual experience (O'Regan and Noë, 2001; Noë, 2004) proposes that at the root of perception always lies a skillful engagement with the world, with an emphasis on the active connotation of the verb to engage. More specifically, perception involves the mastery of the laws of sensorimotor contingencies (SMCs), those regular sensorimotor co-variations that depend on the environment, the agent's body, the agent's internal (neural) dynamics, and the task context and norms.

This theory emphasizes on the claim that all perceiving involves understanding (Noë, 1999, 2004; O'Regan and Noë, 2001). This is not to say that abstract, disengaged reasoning is required. The claim is that the practical, engaged, sensorimotor skills of the whole subject are required for perception. This is the practical sense of the word understanding, which we will adopt throughout this task concerning the classification of question-answers.

3.2.3 Minerva rule-based approaches to question classification

Question processing consists of wording question, answer ranking, and answer formulation. Identifying the candidate answers means taking the results from the wording question phase and further processing it. Often this means doing a full parse of the passage and comparing it to a full parse of the answers. This results in a set of candidate answers that are then ranked according to an algorithm or set of heuristics. As mentioned, one part of the question processing stage is question classification. The derivation of expected answer types is often carried out by means of machine learning approaches.

The question classification in the Minerva project relies on three parts: a taxonomy of answer types into which questions are to be classified, a corpus of questions prepared with the correct answer type classification and a formula that learns to make the actual predictions given this corpus.

For this to be successful, the taxonomy needs to be well designed and the corpus must be correct and of appropriate size. For instance, the maximum number of questions is between 10 and 15 questions per overarching module. The correct prediction of the answer type has in fact been shown to be one of the most important factors for a question answering system to succeed, the ability to correctly identify the expected answer's semantic type.

The above approach is in accordance with Moldovan et al. (2002), mentioned in the following quote:

"Whenever the derivation of the expected answer type [. . .] fails, the set of candidate answers identified in the retrieved passages is either empty in 28.2% of the cases (when the answer type is unknown) or contains the wrong entities for 8.2% (when the answer type is incorrect)."

If question classification is successful, the system might even use different processing strategies (cf. Harabagiu et al. 2001, Kazawa et al. 2001, Prager et al. 2003) to answer different types of questions. Our whole work question classification is taken as synonymous to this specific notion, i.e. the prediction of an expected answer type. Question classification, question categorization, and answer type recognition are used interchangeably. The table below indicates the value of the type of questions, the value of cognitive process in category and subcategory, the level of

modules and the respective overarching module in order to achieve the spatial thinking.

TYPE	VALUE	TAXONOMY	VALUE	SUBCATEGORY	VALUE	level	module
Choose only ONE best answer	0.5	knowledge	0.5		0-57	1	1
True / False	1	comprehension	1		57-75	1.2	2
Drag/drop image	2	application	3		57-93	2	3
Choose ALL answers that apply	4	analysis	4		93-100		4
ranking	3	synthesis	5				
Drag/drop text	3	evaluation	6				

Fig.10 The e-test evaluation system based on Bloom’s taxonomy and type of question

Given a taxonomy of answer types, we also need a machinery for making the actual classification of questions into that taxonomy. As for this, two different approaches can be distinguished; the rule-based classification and the machine- learned classification. This section deals with the former. In the e-test assessment we adopt both the approach of question classification and the one adopted by many (Breck et al. 1999, Eichmann & Srinivasan 1999, Ferret et al. 1999, Hull 1999, Humphreys et al. 1999, Moldovan et al. 1999, Oard et al. 1999, Ogden et al. 1999, Prager et al. 1999, Radev et al. 2002, Singhal et al. 1999), that is to use a, more or less, complex and heuristic form.

3.2.3.1 Questions formulation

Teachers who find ways to help students answer their own questions, first help students to formulate good questions, and then guide students to answer these questions through inquiry and problem-solving. Active learning techniques can be employed in both forming and answering questions, thus fostering students’ sense of curiosity and empowering them to engage in a process of discovery, rather than in one of rote memorization or application of known formulas. Inquiry-based methods, such as the case-study approach, debates, role-playing activities, and simulations promote active learning. Through these types of activities, students begin to assume responsibility for their learning by identifying issues, asking questions, seeking information and developing creative solutions. According to constructivist theories of learning, students who are actively engaged in the discovery process are building their own understanding of the world through experience and reflection upon that experience.

Another conceptual approach to helping students answer their own questions is to apply the lens of research, which involves asking questions, investigating them, and contributing to moving knowledge forward. In some disciplines, such as the sciences, the concept and practice of doing research fit more naturally into coursework with activities such as labs and experiments. However, all disciplines employ techniques of investigation and interrogation, whether of a text, a cultural or historical period or event, or market fluctuations. Sharing your own research questions and investigative processes with students may excite and motivate them. Allowing students to see you struggle and work through the challenges of research may be uncomfortable for you at first, but it will provide them with a model of expert learning and knowledge-creation in your field.

This approach represents a common glossary both in CH and geotechnologies showing different manifestations and capabilities and thus students are able to answer different questions to cover particular needs in terms of spatial knowledge and skills. Minerva approach uses rules operating on words and type of questions as well as on deeply parse information, according to learning outcomes. More specifically:

Type of question: choose only ONE best answer

Knowledge taxonomy

- Queries starting with Where, Whence, or Whither are taken to be of type location.
- Queries starting with Which or What, lookup head noun in lexicon to determine answer type.

Type of question: true /false

Comprehension taxonomy

- Querying a database to determine the types of features existing at a given place answers the question “what is at...?” (i.e. what is the population density of a given city?).
- Finding the location of sites which have certain characteristics responds to the question “where is it...?” (i.e. where are the residential areas within 200m. from a specific river?).

Type of question: drag /drop image

Application taxonomy

- Monitoring how things change over time provides an answer to the question “what has changed...?” (i.e. what is the change in the city?).
- Allowing the description and comparisons of the distribution of phenomena help answer the question “what is the pattern...?”, which in turn can help in understanding the processes which account for their distribution (i.e. is there a pattern in the distribution of findings which are thought to be caused by poverty?).

Type of question: choose ALL answers that apply

Analysis taxonomy

- Calculating the “best” (fastest, quickest, shortest etc.) route between places answers the question “which is the best way...?”, a question related to interaction on earth (i.e. which is the nearest city?).

Type of question: ranking /drag /drop text

Synthesis taxonomy

- Allowing different models of the world to be evaluated, answers are provided to the question “what if...?” (i.e. which areas of a certain valley will be affected if there is a 50-year flood?).

3.4 Instead of epilogue: Dimensions of the question answering

The problem of question answering can be described according to a number of different dimensions, each making the problem more or less complex (Hirschman & Gaizauskas 2001, Harabagiu et al. 2003, Carbonell et al. 2000, Moldovan et al. 2002). These dimensions can roughly be divided into level of understanding and reasoning, type of data used as knowledge source and the actual knowledge sources used for answering questions.

Level of understanding approach can be distinguished by their overall purpose, or level of “understanding”. In this respect they fall into either the category of knowledge or of skills goal setting. Concerning this goal, on the other hand, the approach attempts to answer questions (who, what, when, where, and why) related to both Cultural Heritage and geotechnologies fields (Hirschman et al. 1999). Different types of question answering approaches utilize different

knowledge acquisition. These broadly are linked into the respective lessons references as an article, or book, or links in the web.

Flipped learning environments offer unique opportunities for student learning, as well as some unique challenges. By moving direct instruction from the class group space to the individual students' learning spaces, time and space are freed up for the class as a learning community to explore the most difficult concepts of the course. Likewise, because students are individually responsible for learning the basics of new material, they gain regular experience with employing self-regulated learning strategies they would not have in a "non-flipped" environment.

4. Design and Quality of Online Courses evaluation

Massive open online courses (MOOCs), an innovative technology-enhanced learning model, have offered educational opportunities to a vast number of learners, and have attracted much interest from educational researchers and practitioners around the world (Zhou, 2016).

While acknowledging the potential of MOOCs, some educators have expressed concerns about the pedagogical models based on information transmission that have been widely applied in MOOCs (Albert et al., 2015; Babori et al., 2019; Veletsianos & Shepherdson, 2016; Zhu et al., 2018). Despite the polarized debate, the number of MOOC courses offered and students enrolled have continued to grow, which has aroused the interest of researchers. There have been a substantial number of research studies and reports investigating various aspects and effective practices of MOOCs in recent times, some of which have focused on empirical research.

This chapter will focus on the MOOC MINERVA quality criteria.

4.1 The Quality Criteria

Questionnaire-based surveys can directly and quickly obtain information about the attitudes, behaviors, characteristics, and opinions of MOOC participants, all of which can be used as first-hand data for empirical research. Most questionnaire-based research has made use of measurement scales, with the collected answers quantitatively analyzed to extract value. Researchers considered various factors and used classical models and theories when they designed their questionnaires. Follow-up research is necessary to analyze and summarize this prior work.

MOOQ is the European Alliance for the Quality of Massive Open Online Courses, called MOOCs. The vision of MOOQ is to foster quality in MOOCs leading to a new era of learning experiences.

MOOQ's mission is to develop a quality reference framework for the adoption, the design, the delivery and the evaluation of MOOCs, in order to empower MOOC providers for the benefit of the learners.

The main goal of MOOQ is, therefore, the development and the integration of quality approaches, new pedagogies and organisational mechanisms into MOOCs with a strong focus on the learning processes, methodologies and assessments.

Minerva MOOC evaluation is designed, organized and tested in order to foster high quality Open Education and Learning in Europe and worldwide, in the purpose of teaching and learning Geotechnologies facilitating a new generation in CH. This is realized in close collaboration with all interested partners taking into account both learning process and technological factors that

influence MOOC participants' retention and completion in an efficient way. In other words, MINERVA MOOC evaluation tackles both subjective and objective factors influencing MOOC.

4.1.1 Factors Affecting MOOC Learners' Performance

Learners have various motivations for taking online courses (Carlos et al., 2017), which can affect their attitude and intention to continue learning in MOOCs. The performance of learners attending a MOOC can be used as an essential reference for improving MOOC design and quality.

The main subjective factors include learners' preferences (Li et al., 2018), experience (Li et al., 2018; Zhao et al., 2020; Zhou, 2017), expectancy (Botero et al., 2018; Luik et al., 2019; Zhou, 2017), and psychological motivation (Botero et al., 2018; Yang & Su, 2017; Zhou, 2016).

Objective factors include course quality (Hone & El Said, 2016; Yang et al., 2017), network externalities (Li et al., 2018), social motivation (Jung & Lee, 2018; Khan et al., 2018; Wu & Chen, 2017), and MOOC systems (Wu & Chen, 2017).

Learners' performance in MOOCs is measured by course engagement, social interactions, sociability, and learning gains. Many studies have focused on the factors that influence learners' performance (Carlos et al., 2017; Kahan et al., 2017; Soffer & Cohen, 2015; Zhang, 2016).

From the articles reviewed, we summarized the major factors affecting learners' performance into four categories, that is motivation, self-regulated learning (SRL), self-perception and learning strategies. In fact, learners with different motivations for participating in a MOOC focus on different learning goals and strategies (de Barba et al., 2016; Watted & Barak, 2018).

General MOOC participants are divided into two groups. The first group is oriented toward acquiring knowledge and professional advancement, while university-affiliated students are also concerned with a need to obtain certificates.

Independently of their expectancies and in the purpose to accomplish an efficient learning model, Minerva MOOC provides the following items in order to accomplish the setting goals. First of all, a learning strategy that conforms to the following four dimensional theoretical structures; cognitive learning, affective learning, behavioral learning and social learning (Watson et al., 2016). Moreover, the Self-Regulated Learning (SRL), a learning strategy that influences MOOC learners' performance in order to enhance students' knowledge and skills in a respective subject matter and it requires calls for completing course content, making full use of platform resources, and allocating study time reasonably (Jansen et al., 2017; Kizilcec et al., 2017; Maldonado-Mahauad et al., 2018). Finally, the didactic process that is defined as a complex plan for a learning process that learners have purposefully and consciously formulated to improve their learning effectiveness and performance in MOOCs (Kizilcec et al., 2017; Maldonado-Mahauad et al., 2018).

4.2 Assessment of MOOCs

Minerva MOOC purpose is to investigate the overall assessment of MOOCs, that is both the evaluation of the learning model, of the module structure and of the lesson design, such as the MOOC platform technology, and the benefits from participating in MOOCs.

In this phase, we examined assessment from the perspective of learners in bachelor and master level. The assessment from teachers' point of view is not assessed.

Based on a Systematic Review of Questionnaire-Based Quantitative Research on MOOCs (Lu, Cui, Huang, Zhao, Li, and Wang 290) realized from 3 until 7 October, during the training in the

University of Nis, the evaluation provides and focuses, on the one hand, on student-oriented research using learners' perceived benefits to determine the learning design that helped learners meet their goals (Jung et al.,2019; Lowenthal et al., 2018), and on the other hand on evaluation of learning skills acquired during the training in beta platform in order to approve the challenges, as well as opportunities for future in MOOCs development (Donitsa-Schmidt & Topaz, 2018; Gan, 2018).

In the following figure, the teaching and learning strategy factors are presented



Fig11 Minerva teaching and learning strategy factors

The components evaluated in Minerva MOOC contain three (3) items, that is, internal goal, external goal and learners' performance concerning the respective factors, as the above figure shows, that is instruction, motivation, usability and interactivity.

More specifically:

- *Instruction* refers to strategic planning according to the goal settings provided by implementation, in order to accomplish learning strategy through lectures, lessons, assessment and assignment that help students grow their motivation.
- *Motivation* refers to a corpus of didactic process, such as labs based on project based learning, research based learning and teams based learning, in order to enhance social influence according to individuals' benefits that help to enhance students' knowledge and skills in the respective subject matter.
- *Usability* refers to the tools activated in order to help students to achieve the external goal of the learning strategy that is Self –Regulated Learning (SRL) and Self-Perceived process. It calls for completing course content, making full use of platform resources, and allocating study time reasonably.
- *Interactivity* refers to learners' performance that is accomplished through didactic process and helps students require the social and behavioral process to the respective setting goals, such as spatial skills, spatial thinking and solving problems in real life. This item is responsible for improving students' learning effectiveness and performance.

The questionnaire results of the Minerva MOOC evaluation figures in the below section.

4.3 Instead of epilogue

MOOCs represent a unique opportunity to revive long distance academic cooperation. All in all, BL is Blended courses that combine online with face to face teaching in a planning and educational manner. Nevertheless, there are many chances to improve the learning mechanisms in MOOC, such as more effective learning platforms and learning support services, to empower easier access and better learning for both students and professionals.

One of the biggest criticisms of MOOCs has been that learner-instructor interaction is completely absent and learner-learner interaction is inefficient at best. But this is starting to change. New learning platforms and models are being tested to enhance learning in MOOCs by making the courses more social and more collaborative.

After generation "Z" a digital native generation will come whose educational, social, and professional lives take place largely online. These young people expect their training to be just as digitally connected as the rest of their lives. In the present, MOOCs provide only one part of the answer. The second part is to provide new learning models in order to retain the learning content quality in the specific domain.

4.4 Results

The responses acquired from the questionnaire shared with learners during the training, focuses on understanding the design elements of learning strategy applied, such as knowledge construction, self-regulation, real-world problem-solving and innovation, for the use of Geotechnologies for learning, and skilled Cultural Heritage students, are analyzed below. For good understanding of knowledge, construction of knowledge built through analysis, interpretation, synthesis, evaluation and application were considered. Lack of awareness and implementation of these features were regarded as poor understanding of knowledge construction.

Personal characteristics are provided concerning the educational level, the age, the gender. The responders are 8 males and 6 females in a total of 14 students. The age average is 30 years.

Previous experience and effectiveness

The previous experience divides the responders into two groups, that is 50% those having a previous experience and 50% those not.

As for the question about the MOOC technology and the level of learning effectiveness, responders are positive in rank average 4.8%, thus they are very likely to take up another online course.

Teaching and Learning structuring

Concerning the teaching and learning structuring that means instructions, responsiveness and methods applied, responders mentioned that "the instructions explain in a way that I can understand", in a rank average 4.6%, the "instructor clearly presented the skills to be learned" in a rank average 4.6%, and the "instructor stimulates my interest in the subject matter" in a rank average 4.4%.

Lesson design

The lesson design concerns the balance between lecture and practice. The responders answered that the course provides an appropriate balance between lecture and practice in rank average 4.3% and the assignments and lectures complete each other in a range average 4.1%.

Motivation

The motivation lays in a rank average 4.6% about appropriate requirements for the course level and 4.3% for the inquiry learning that is the case studies that “measured my knowledge of the course material”.

Learning outcomes

In the question student learning outcomes, the responders answered that *“I am motivated to take responsibility for my own learning in this course”* in a rank average 4.7%, *“the course develops my ability to think spatially”* in rank average 4.6% and finally, *“the course developed my ability to solve problem about my subject”* in a rank average 4.1%.

The rank average about the understanding before entering in this course 2.2% and after taking this course 3.9%, shows the achieved performance of the learning outcomes. In an average 71% this experience helped to develop skills, in an average 79% recommended service-learning courses to others, 57% would like to take other courses involving their learning experience.

Service facility

43% of the responders evaluate the quality of the laboratory facility as excellent, 36% as good, and 21% as adequate. This shows that the labs’ contribution for understanding lectures are *sufficient 71%, a lot 21%*, and some students mentioned as *medium 7%*. About MOOC service facilities the responders enhance the learning through *interactivity with others 93%, connect and extend knowledge from academic study 71%, increase sociability 21%* and finally, *reflect on their own values 14%*.

Self-evaluation

The self-evaluation shows the self-perception of students: *“In this course, I have been challenged to learn more than I expected” 21%*, *“The course was challenging” 29%*, *“the course made me think” 50%*.

Learners’ expectancy

Students’ grade expectancy to learn in this course, the options for this question are graded as *uncertain (43%), module 1 (29%), module 2 (7%), module 3 97%) and module 4 (14%)*.

In the question *“How would you rate this course as a learning experience?”* 7% of the students responded *“Overall, this instructor met my expectations, 36% “I would recommend this course to others”, 21% “Overall, this course met my expectations”, 29% “This course had high educational impact”* and finally, 7% *“This course was useful in progress toward my degree”*.

In the open question respondents answered *“more individual and group activities”* and *“more practical application of knowledge obtained from the course through exercises and projects”*.

The students, also, ranked the obstacles; *lectures 21%, labs 43% and instructions 36%*.

In the question *“what changes might improve your learning”* students answered as following:

- *There should be more exercises and practical work. Maybe just easier access to the platform. Overall, everything else was done very well.*
- *Having the same kind of voice in every lesson could be an improvement to standardize the modules and make the experience faster and easier.*
- *There should be a lot of exercises for everyone connected of course to a lesson.*
- *As this course was meant to test the project through the students' feedback, I do not think that it needs to be changed in order to improve my learning. On the other hand, I believe that the course's aim (collecting feedback to improve the project) has been reached because we all gave suggestions on how to implement or what to change to make it easier to understand GIS procedures.*

- *I would like to have an access to online lectures. More practice and maps creation.*

4.4.1 Comments and Survey evaluation

The process of reflection is evidently at work during this evaluative activity. However, it is difficult to clarify if some of the students realized that some of the work they had done was not knowledge construction but mere knowledge reproduction.

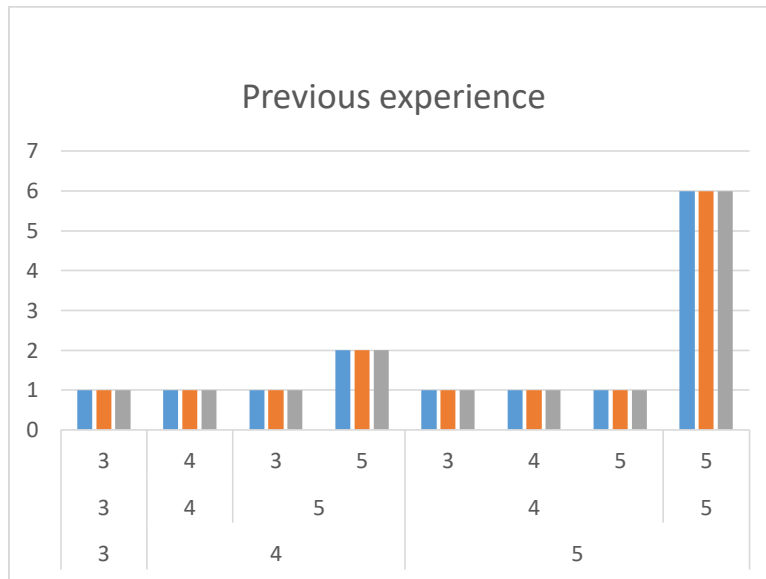
The learners' expectancy is difficult to recognize and balance in knowledge and skills terms. However, this question mentions the needs for their subject matter. Consequently, it is very difficult to determine whether students knew the necessity of previous lessons, due to the lack of understanding of the GIS process.

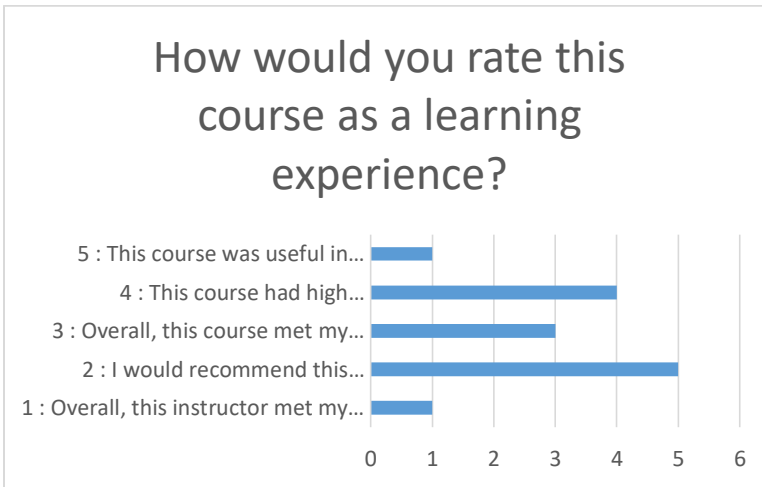
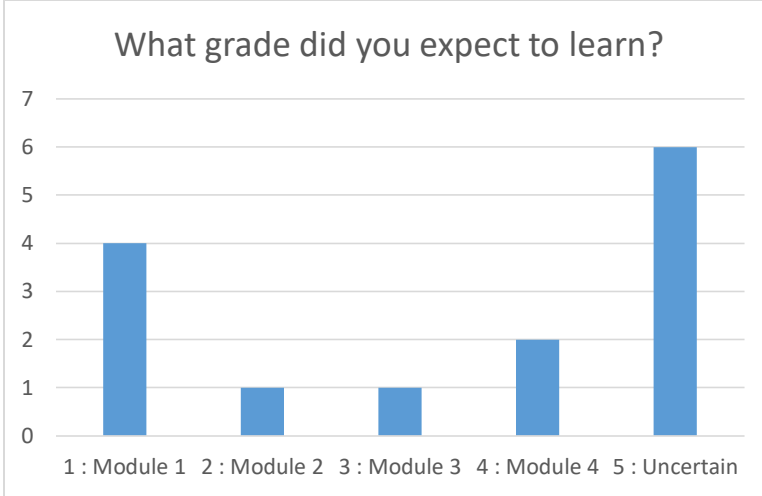
From a review of the students' comments, it is evident that their awareness of self-regulation features was high.

Many other aspects related to real-world problem solving have already been covered elsewhere in the discussions above since these questions are interrelated. In contrast, the concept of innovation was not clearly articulated by the students. We also acknowledge the reasonable suggestions they made to improve the design of their chosen MOOC in terms of usability and accessibility.

In this phase, different didactic material and case study were used to investigate students' reflections after their participation in the training in the MINERVA MOOC. This was done for the purpose to inform creators about their understanding of design elements.

The conclusion that can be drawn from this study is that the overall understanding of the design elements was good for knowledge construction, self-regulation, real-world problem solving and innovation, as well as use of GIS for teaching and learning CH students.





Survey of MOOC evaluation

Feedback Training

1 Personal characteristics (Status, gender, age)

Respondent	Response
	MA, PhD Student, female, 29
	Master student, male, 25
	Student, female, 19
	student, male, 24
	Student, male, 27
	student, femmina, 41
	Student, female, 30
	Architect, male, 38
	MA, PhD Student, masculin, 29
	Single, female, 26
	Student, male, 25
	Student. Male. 20
	Single, female, 21
	Student, man, 26

Total responses to question 14/14

2 Is this your first time taking an online course?

Response	Average	Total
Yes	50%	7
No	50%	7

Response	Average	Total
Total responses to question	100%	14/14

3 The technology in this course effectively supported my learning.

Response	Average	Total
Yes	100%	14
No		0

Total responses to question 14/14

4 How likely would you be to take another online course?

	Average rank					↓
	1	2	3	4	5	
Unlikely to very likely						4.8
Responses	1	2	3	4	5	Total
Unlikely to very likely	0	0	0	3 (21%)	11 (79%)	14

5 Teaching environment structuring: Instructions Responsiveness and Method

	Average rank					↓
	1	2	3	4	5	
The instructions explain course content in a way I could understand						4.6
The instructor clearly presented the skills to be learned						4.6
The instructor stimulates my interest in the subject matter						4.4
Responses	1	2	3	4	5	Total

Responses	1	2	3	4	5	Total
The instructions explain course content in a way I could understand	0	0	1 (7%)	4 (29%)	9 (64%)	14
The instructor clearly presented the skills to be learned	0	0	1 (7%)	4 (29%)	9 (64%)	14
The instructor stimulates my interest in the subject matter	0	0	3 (21%)	2 (14%)	9 (64%)	14

6 Course design

						Average rank	↓				
						1	2	3	4	5	
The course provides an appropriate balance between lecture and practice											4.3
The course assignments and lectures usefully complement each other											4.1
Responses	1	2	3	4	5	Total					
The course provides an appropriate balance between lecture and practice	0	0	2 (14%)	6 (43%)	6 (43%)	14					
The course assignments and lectures usefully complement each other	0	0	3 (21%)	7 (50%)	4 (29%)	14					

7 Motivation

						Average rank	↓				
						1	2	3	4	5	
The course workload and requirements are appropriate for the course level											4.6
The cases studies measured my knowledge of the course material											4.3
Responses	1	2	3	4	5	Total					
The course workload and requirements are appropriate for the course level	0	0	2 (14%)	2 (14%)	10 (71%)	14					
The cases studies measured my knowledge of the course material	0	0	3 (21%)	4 (29%)	7 (50%)	14					

8 Student Learning outcomes

						Average rank	↓				
						1	2	3	4	5	
I am motivated to take responsibility for my own learning in this course											4.7
The course develops my ability to think spatially											4.6
The course developed my ability to solve problem about my subject											4.2
Responses	1	2	3	4	5	Total					
I am motivated to take responsibility for my own learning in this course	0	0	0	4 (29%)	10 (71%)	14					
The course develops	0	0	0	5 (36%)	9 (64%)	14					

Responses	1	2	3	4	5	Total
my ability to think spatially						
The course developed my ability to solve problem about my subject	0	1 (7%)	2 (14%)	4 (29%)	7 (50%)	14

9 Please rate your performance or understanding of the following course learning outcomes, according to the scale provided

	Average rank					↓
	1	2	3	4	5	
Before entering this course						2.2
After taking this course						3.9
Responses	1	2	3	4	5	Total
Before entering this course	4 (29%)	5 (36%)	4 (29%)	0	1 (7%)	14
After taking this course	0	1 (7%)	2 (14%)	8 (57%)	3 (21%)	14

10 How would you rate the overall quality of the laboratory facility?

Response	Average	Total
excellent	43%	6
good	36%	5
adequate	21%	3
Total responses to question	100%	14/14

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11 The lab complements my understanding of the lectures

Response	Average	Total
medium	7%	1
sufficiently	71%	10
a lot	21%	3
Total responses to question	100%	14/14

12 To what extent has this course contributes to your ability to

Response	Average	Total
Connect and extend knowledge from academic study to service learning and vice versa.	71%	10
Critically reflect on my own values and ideals in light of my service learning experience.	14%	2
Critically reflect on my efficacy in bringing about desirable social change and on my commitment to such change.	21%	3
Work with people of diverse backgrounds and to learn from this experience through effective communication, listening, and adaptation.	93%	13
Total responses to question	100%	14/14

13 To what extent do you agree with the following statements?

Response	Average	Total
This experience helped me develop skills and/or knowledge that will make me more effective at serving my community in the future.	71%	10
I believe I can make a positive difference in the domain.	50%	7

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Response	Average	Total
I would like to take other courses that involve service-learning experiences.	57%	8
I would recommend service-learning courses to other students.	79%	11
Total responses to question		14/14
14 How satisfied were you with your effort in this course?		
Response	Average	Total
In this course, I have been challenged to learn more than I expected.	21%	3
The course was challenging.	29%	4
The course made me think.	50%	7
Total responses to question		14/14
15 What grade did you expect to learn in this course?		
Response	Average	Total
Module 1	29%	4
Module 2	7%	1
Module 3	7%	1
Module 4	14%	2
Uncertain	43%	6
Total responses to question		14/14
16 How would you rate this course as a learning experience?		
Response	Average	Total

Response	Average	Total
Overall, this instructor met my expectations.	7%	1
I would recommend this course to others.	36%	5
Overall, this course met my expectations.	21%	3
This course had high educational impact.	29%	4
This course was useful in progress toward my degree.	7%	1

Total responses to question  100% 14/14

17 Please identify what you consider to be the strengths of the course:

Response	Average	Total
Lecture	64%	9
Labs	43%	6
Instructions	71%	10

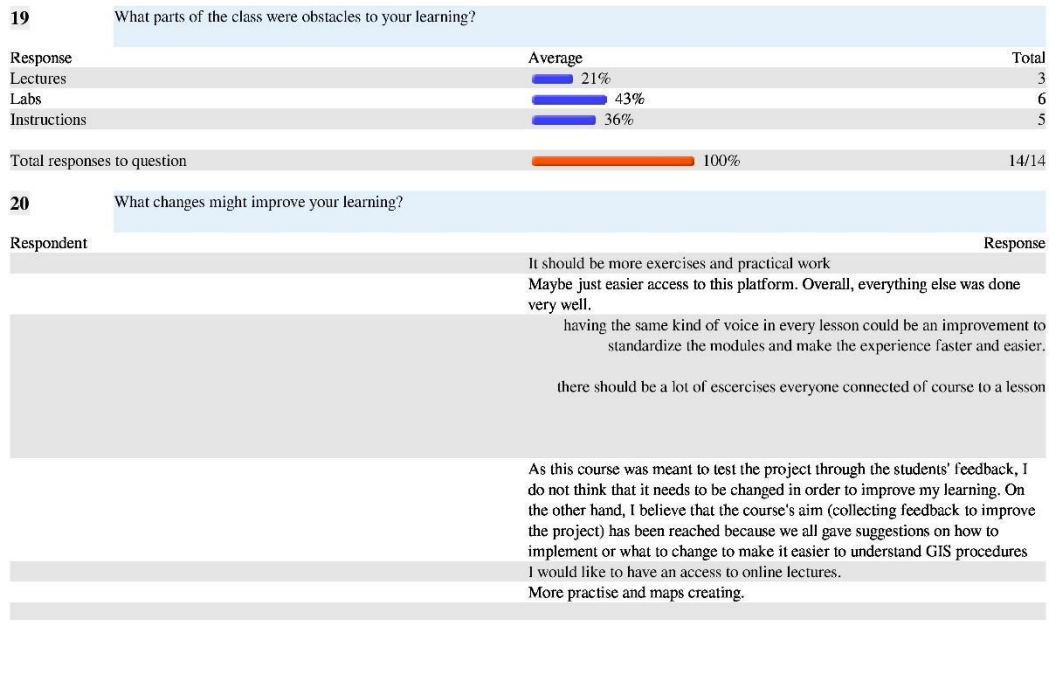
Total responses to question  100% 14/14

18 Please identify area(s) where you think the course could be improved:

Response	Average	Total
Data collection	29%	4
Data management	29%	4
Data analysis	29%	4
Data visualization	21%	3
Exercises	71%	10

Total responses to question  100% 14/14

Respondent	Response
	More individual and groupal activities More practical application of knowledge I obtained from the course through exercises and projects
Total responses to question	8/14



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