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competence framework for teaching geotechnologies for cultural heritage

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ABOUT THE AUTHORS

Partners	Names
Research Centre of the Slovenian Academy of Sciences and Arts	Jani Kozina Rok Ciglič
University of Florence	Lucilla Spini

OTHER CONTRIBUTORS

Partners	Names
Dipylon	Maria Pigaki Maria Karagiannopoulou Evi Sempou Aspasia Tsatsouli
Research Centre of the Slovenian Academy of Sciences and Arts	Erik Logar Peter Repolusk
University of Castilla - La Mancha	Carmen Garcia Martinez Francisco Javier Jover Martí Juan Antonio García González Francisco Cebrián Abellán Irene Sánchez Ondoño Pablo Valero Tocohulat
University of Florence	Margherita Azzari Pauline Deguy Paola Zamperlin Giorgio Barbato Andreas Robert Formiconi Carmelo Pappalardo Vincenzo Bologna
University of Jean Monnet-Etienne	Pierre-Olivier Mazagol Olivier Leroy Michel Depeyre
University of Niš	Vladimir Aleksić

ABOUT THE PROJECT

The MINERVA project is based on transdisciplinary and transnational tools that will be used to develop the efficiency of the learning approach in Cultural Heritage and Geosciences.

Three actions will be analysed. In the first stage, the teaching process will be examined, focusing on HOW the teaching and learning of Cultural Heritage are organized at the academic level. It then aims to examine the design concept; WHAT are the needs and WHICH tools are used. The third stage aims to define WHO is involved in the teaching process. As a result, using cognitive approaches, the tools that will be developed will reflect both the dialectical and the interactive relationship between methods and knowledge, thus engaging students in a learning action using geosciences.

More specifically, the three main actions of the MINERVA project will be achieved with the following steps:

- Learning: defining the learning needs of the students with a detailed comparison between the requirements of the labour market at European level and the academic profiles related to Cultural Heritage.
- Thinking process: proposing a holistic approach linking the Humanities to the Geosciences in order to promote spatial thinking. A new teaching tool for graduate and postgraduate students adapted to a personalized learning approach will be designed. 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.
- Implementation: activating innovative teaching methods and resources in a structured course that offers a flexible and dynamic learning experience, available on the FEDERICA platform; specifically designed to offer Massive Open Online Courses (MOOC).

Finally, the project MINERVA is structured to meet the current circumstances where effective distance learning and working tools and electronic platforms are needed.

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0 EXECUTIVE SUMMARY

The Competence Framework for Teaching Geotechnologies for Cultural Heritage in Europe aims to assess the level, needs and potentials of integrating geographic information systems (GIS) into cultural heritage (CH) in higher education courses and professional labour market activities. Based on the evidence from several European countries knowledge about GIS and CH is extensive and diverse, but not interconnected and scattered across different disciplines and teaching programs. No country has a systematic inventory of geotechnologies competences that could be integrated into CH studies and vice versa. However, there is a great need for such linkage in everyday CH tasks and applied projects, but no one has yet systematically analysed this relationship and designed a common framework to address the need for connecting these two fields.

The document is structured around three main sections. The first section provides an inventory of competences in the field of GIS for CH. The inventory is based on a large-scale survey of university teachers and experts in the labour market in selected European countries. The results provide a complete and concrete understanding of the specific competences required of learners in the European labour market. The second section builds on the inventory and defines the main characteristics of a course on GIS for CH and the correct positioning of the course in the grading scale of European Credit Transfer and Accumulation System (ECTS) of higher education institutions, as well as new modes of credentials (mainly “micro-credentials”). The last section presents an assessment tool for students' didactic progress. It allows measuring the competences and skills acquired by the students. Principles of sequencing, progression and flexibility in knowledge are applied to offer a valid type of program with different standards and levels.

In order to carry out an inventory of competences in the field of GIS for CH, an online survey was conducted among three target groups (GIS teachers, CH teachers, and CH experts) in France, Greece, Italy, Serbia, Slovenia, and Spain between December 2020 and January 2021. The sample of 649 respondents presents a diverse set of actors encompassing various backgrounds and skills (in GIS and CH), and types and sizes of institutions, which pertain to a wide generalizability of the results.

The main findings from studying the competences of higher education teachers show that there is a great potential and willingness for the integration of GIS and CH subjects. Both types of teachers could collaborate more often in developing theoretical and applicative solutions in the fields of GIS for CH. Currently, they behave quite similarly when it comes to main sources for teaching GIS. The most utilized category is ‘learning by doing’ where teachers put a lot of emphasis on practical work and illustrative-demonstrative methods. E-lessons and online courses are dominated by other conventional teaching and learning methods. These facts may indirectly indicate a need to develop such online tools to be more efficiently and widely used by teachers and learners. GIS teachers use commercial and non-commercial software and online applications more frequently than CH teachers. However, both groups prefer using non-commercial versions (e.g., QGIS and free services of Google Maps). The most frequent hardware is still a desktop computer. Most of the GIS tasks are done at regional level, followed by local and nationwide levels. Vector data represent the most important source of data for both types of teachers. However, GIS teachers more often use also other forms of data (e.g., raster and tabular). The most frequent topics in data management in GIS and CH education are querying, relating data (tables) and conversions. These tasks present the basic geoinformation activities that are frequently needed before the start of any other processes. There are some differences in data acquisition between both types of teachers. GIS teachers’ tasks involve digitizing analogue data (scanning and georeferencing), data harvesting, field mapping with GNSS devices, remote sensing, and geocoding, while CH teachers more commonly use data harvesting, digitizing analogue data, topographic surveying, and geocoding. GIS teachers often perform vector analysis (involving proximity, overlay, etc.), combination of raster and vector analysis, raster map algebra, and vector network analysis, while CH teachers often perform photogrammetry, vector network analysis, and combination of vector and raster tasks. GIS teachers also include some programming tasks in their analysis, but CH teachers practically do not. GIS and CH teachers have a similar relationship of tasks in data presentation. They mostly practice cartography of digital maps, followed by cartography of printed maps or web application building. Approximately one third of teachers also involve 3D modelling.

The main observations from studying the labour market and higher education matchmaking revealed that CH experts are in significant need of external GIS support to enrich their professional work. They outsource tasks from all GIS stages (e.g., acquisition, analysis, visualization). Most often, they need support for mapping and other tasks such as digitization, georeferencing, data analysis, and 3D modelling. Those CH experts that use GIS in their professional work most often apply simple tasks of using the spatial databases (e.g., identification, querying, management). Thus, there is a great potential to intensify knowledge transfer of GIS from the academic environment to the professional sphere. The generations of CH students should enter the labour market with better knowledge on GIS tools and methodologies for CH. Compared to higher education teachers, CH experts more often use unmanned aerial vehicles (UAV or drones) next to other specific GIS devices. Therefore, this emerging field should get more attention in educational programs. CH experts compared to higher education teachers more commonly deal with GIS at local level (an area of a few square meters or hectares). Therefore, more focus to precise local level should be dedicated in the future education processes (e.g., by using a specific archaeological site as a learning example) as the university teachers prefer using a regional level. According to the CH experts' tasks in data management, current education content seems sufficient. However, the analysis showed that emphasis on access management and, especially, metadata management should be intensified. These kinds of tasks are especially important in different heritage registers, repositories and similar institution with lots of material and data (e.g., museums). According to CH experts' tasks in data acquisition, some more attention to topographic surveying should be dedicated in higher education. Additionally, CH experts wish to improve their skills in geotagging, which connects different material (e.g., photos) with spatial location. Concerning data analysis, photogrammetry, 3D modelling and topology checks should be more involved in education processes. Photogrammetry and 3D analysis are especially helpful for tasks such as detailed research and preservation of cultural heritage sites, statutes, etc. CH experts estimate that knowledge on how to present 3D models and web applications should be improved. The study shows that the presentation of results is obviously often connected to the digital media. This is not surprising, since nowadays, there is a strong wish for detailed virtual reality implementation in various fields, including CH.

On the basis of the above-mentioned findings, and building on existing good practices in Europe, an overview of the general structure and features of a course in Geotechnologies for Cultural Heritage has been developed by defining its main overarching modules (i.e., introduction, data acquisition, data management, data analysis and data visualization) and by providing examples of content (e.g., georeferencing, GIS for CH and landscape analysis, cartography and mapping) and information on expected skills to be acquired by the students.

To advise CH teachers towards planning and defining syllabi for these types of courses within academia, with specific reference on the utilization of the upcoming MOOC on Geotechnologies for CH, the MINERVA Partners have identified the positioning of the course within the levels of the European higher education and the European Credit Transfer and Accumulation System (ECTS).

Building on the MINERVA partners' experience, specific examples on the different schemes for the utilization of the MINERVA MOOC (or part of it) in university courses and training programs (e.g., summer schools, "self-teaching" courses, practical traineeship or internship, level 6 and level 7 courses, and stand-alone Master's degree) have also been outlined according to national and institutional needs and requirements.

Furthermore, the potential utilization of this MOOC has also been recognized for standalone training courses and self-learning opportunities which can fulfil the requirements of the labour market and the needs of learners beyond university, namely CH practitioners/professionals. Thus, the positioning of the MOOC has also been framed within more flexible type of certifications with a specific focus on micro-credentials, also by referring to the increasing number of MOOCs, the growing use of such credentials, and to the pressing need for harmonization of micro-credentials across Europe. Upon defining the certification frameworks (e.g., ECTS and micro-credentials), the assessment tools for evaluating student's didactic progress have been examined taking into account both the Dublin Descriptors' framework and the specific learning outcomes for the course's main overarching modules.

The MINERVA MOOC has been conceived as open and accessible to all those who register for it, independently whether or not they want to obtain certifications (e.g., ECTS, micro-credentials, Master degree), as well as inclusive of an entrance test to assess the level of potential learners and to provide advice on the possible certified pathways within the MOOC (incl. related information on enrolment and fees). A series of diagnostic and formative assessment tests and exams are available throughout the modules for those learners who have fully enrolled in the MOOC; this is intended to allow for assessing progress towards the learning outcomes, for further engaging the learners, and for providing interim certifications (e.g., ECTS). Upon completion of all the modules and *in itinere* tests and exams, a final exam enables the learners to pursue the award of the Master's degree. Such an exam has been identified as an open-ended project which upon appropriate review and finalization could be fed into the MOOC's content – this would enable to update the MOOC with new developments in the application of geotechnologies for CH and to ensure further discussion, cooperation and innovation on geotechnologies for cultural heritage.

The Competence Framework for Teaching Geotechnologies for Cultural Heritage in Europe finally provides the foundation for the forthcoming Teaching Methods of Geotechnologies and Didactic Resources on Geotechnologies for Cultural Heritage, as well as the main content of the Massive Open Online Courses (MOOC) in Geotechnologies for Cultural Heritage. Both intellectual outputs are well under way within the project MINERVA.

1 INTRODUCTION

The first intellectual output (IO1) of the project MINERVA is a Competence Framework for Teaching Geotechnologies for Cultural Heritage in Europe. The aim of IO1 is to assess the level, needs and potentials of integrating geotechnologies encompassing geographic information systems (GIS) into cultural heritage (CH) in higher education courses and professional labour market activities. The IO1 builds heavily on Digital Competences Framework of Educators (Redecker 2017) by matching teaching competences with competences needed in the labour market. There is a particular focus on Area 3 - Teaching and Learning. The IO1 also provides the foundation for developing the other two MINERVA's intellectual outputs: Teaching Methods of Geotechnologies and Didactic Resources on Geotechnologies for Cultural Heritage (IO2), as well as the main content of the Massive Open Online Courses (MOOC) in Geotechnologies for Cultural Heritage (IO3).

Based on the evidence from the countries of the project partners (France, Greece, Italy, Serbia, Slovenia and Spain), knowledge about GIS and CH is extensive and diverse, but not interconnected and scattered across different disciplines and teaching programs. No country has a systematic inventory of geotechnologies competences that could be integrated into CH studies and vice versa. However, there is a great need for such linkage in real life and practical projects, but no one has yet systematically analysed this and designed a common framework to address the need for linkage between the two fields.

IO1 develops a framework that is missing in the pedagogical context of didactic supports/aids/tools. It is the first framework developed specifically with the goal of integrating such technical skills into humanities curricula. Moreover, the identification of knowledge and specific skills currently required by the management of CH is a guarantee of success in adapting the higher education courses to the needs of the labour market.

The target audience for IO1 are European university teachers, bachelor and master students (directly and indirectly) and experts on the labour market in the fields of humanities, arts, cultural management, etc. The Competence Framework enables the creation of courses and teaching materials useful for curriculum integration, and provides useful support for those already working professionally but needing to acquire/update specific skills for operators, in particular: public administrators, museums, libraries, archaeological sites, tourism companies, private consultants, international non-governmental organisations, natural and cultural parks and sites, etc.

Following this introduction, the report is structured around three main sections (chapters 2-3-4) and two appendices. Chapter 2 provides an inventory of competences in the field of geographic information systems for cultural heritage. The inventory is based on a large-scale survey of university teachers and experts in the labour market in all six countries of the project partners (France, Greece, Italy, Serbia, Slovenia and Spain). The results provide a complete and concrete understanding of the specific competences required of learners in the European labour market. Chapter 3 builds on the inventory and defines the main characteristics of a course on geotechnologies for cultural heritage and the correct positioning of the course in the grading scale of European Credit Transfer and Accumulation System (ECTS) of higher education institutions, as well as new modes of credentials (mainly "micro-credentials"). Chapter 4 presents an assessment tool for students' didactic progress. It allows measuring the competences and skills acquired by the students. Principles of sequencing, progression and flexibility in knowledge are applied to offer a valid type of program with different standards and levels.

2 INVENTORY OF COMPETENCES IN THE FIELD OF GEOTECHNOLOGIES FOR CULTURAL HERITAGE

2.1 RESEARCH DESIGN

In order to assess the level, needs and potentials of integration of geographic information systems (GIS) in cultural heritage in **higher education** and the **labour market**, the online survey was conducted simultaneously between December 2020 and January 2021 in six partner countries: France, Greece, Italy, Serbia, Slovenia and Spain. A draft questionnaire was prepared in English by the Slovenian partner ZRC SAZU (with a contribution from all project partners). Some of the questions were tailored to the specific target group and some were the same for all three groups:

- **GIS teachers** → Teachers in higher education that significantly incorporate GIS in their curriculum. They are usually members of universities dealing with spatial sciences such as geography, geodesy, architecture, landscape architecture, urban and regional planning, urbanism, civil engineering, etc.
- **CH teachers** → Teachers in higher education that significantly incorporate CH in their curriculum. They are usually members of universities dealing with culture and heritage such as art, history, art history, ethnology, anthropology, archaeology, geography, architecture, cultural studies, cultural economics, cultural tourism, museology, conservation, restoration, law studies, etc.
- **CH experts** → Professionals that work as individuals or in institutions dealing with preservation, development or promotion of cultural heritage. Their orientation can span between the **intrinsic value** of cultural heritage as collective memory of the society and its **instrumental value**, which is expressed in the social and economic value of cultural heritage. They can be part of the public or private sector.

Table 1: Identification of target groups through fields of higher education (GIS or CH) and types of activity.

		Types of activity	
		Higher education	Labour market
Fields of higher education	Geographic information systems (GIS)	YES	NO
	Cultural heritage (CH)	YES	YES

The integrated definition of cultural heritage, as presented by UNESCO and according to the principles of European Landscape Convention, entails a new way of conceptualising cultural heritage that strongly correlates with territory. Geotechnologies, historical databases and geovisualization offer the possibility to highlight interaction factors in a given territory and to describe phenomena and processes that have taken place in a given area. Geotechnologies are increasingly closely related to the management of cultural heritage, an area that requires professionals to have skills in the use of innovative tools (3D Modelling, Remote Sensing, Laser Scanning, Lidar Data /Lidar surveying method, etc.).

Burrough, McDonnell, and Lloyd (2015) see three major components of GIS: computer hardware, software (applications, programs, modules), and users connected by databases and network infrastructure. Another basic definition presents GIS as a "set of tools for collecting, storing, retrieving at will, transforming, and displaying spatial data" (Burrough 1986; Burrough and McDonnell 1998 cited in Burrough, McDonnell, and Lloyd 2015). A similar classification provides that GIS is "a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information" (USGS 2013 cited in Burrough, McDonnell, and Lloyd 2015). "GIS are, in short, computer-based methodologies for processing geographical data" (Okabe 2006). The following sub-processes were also recognized by Okabe (2006): 1. acquiring, 2. managing, 3. analysing, 4. visualizing. Similarly, Wagner (2018) describes GIS as "combined systems of hardware and software that facilitate the storage, analysis, and display of spatial data".

Therefore, the questionnaire strived to gather information on **identification of target groups** (what is their main focus, what is their organizational structure, what are their demographic characteristics, etc.), **basic characteristics of GIS involvement** (desired and actual involvement of using GIS in teaching and professional work, main sources for teaching GIS, etc.), **usage of hardware and software** (what kind of equipment do they possess) and what kind of GIS tasks do they perform, teach, or need:

- **Usage of GIS for data management;**
- **Usage of GIS for data acquisition;**
- **Usage of GIS for data analysis;**
- **Usage of GIS for data visualization and presentation of results.**

The questionnaire was translated into six national languages and disseminated to all three target groups through an online platform 1KA[1] (see appendix 6.1). Every partner was responsible for disseminating the questionnaire among the target groups in its own way through various channels such as mailing lists, personal contacts, publicly available emails, publicly published invitations to fill out the questionnaire, etc. The details for each country are as follows.

The **French** team wrote specific emails with an invitation to fill out the questionnaire to several researchers, specialists and managers in cultural heritage, widely shared the questionnaire via social networks like Twitter or LinkedIn, and used different mailing lists:

- EVS lab's internal mailing list (over 350 geographers, historians, architects, anthropologists, engineers, etc. from several universities and schools);
- Geotamtam mailing list (with over 5.000 French-speaking members, mainly geographers but also GIS specialists or users in several fields);
- GDR Magis' mailing list, a French CNRS interdisciplinary research network about "Methods and Applications in Geomatics and Spatial Information" (with over 300 geographers and computer scientists members);
- Master Geonum alumni mailing list (Geonum for NUMeric GEOgraphy) (with almost 150 GIS specialists members).

The **Greek** team diffused the questionnaire via various networks and mailing lists of multiple, interdisciplinary Dipylon's collaborators. The category of GIS teachers was addressed through the universities involved in GIS teaching, e.g., National Technical University of Athens. The category of CH teachers was addressed through the universities involved in cultural heritage, e.g. University Departments of Cultural Heritage Management & New Technologies. The category of CH experts was

[1] https://www.1ka.si/d/en

addressed through the colleagues of the Ministry of Culture, Ephorate of Antiquities, National and Private Museums, and public and private institutions specialized in cultural heritage. Finally, the questionnaire was disseminated to a wider audience specialised in geography, archaeology and GIS through the Hellenic Geographical Society.

The **Italian** team used mailing lists of the professors of the University of Florence and sent invitations to various institutions dealing with the conservation of cultural heritage. The category of GIS teachers was addressed through the Association of Italian Geographers (373 members). The category of CH teachers was addressed through the universities' contacts, in particular the directors of schools specialised in cultural heritage (Florence, Rome, Pisa, Padua, Bologna, Salerno, Siena, Milan, Naples, Genova). For the category CH experts, publicly available emails were used and invitations were sent to several relevant institutions such as National and Regional Agency for CH protection, Archive, Library, Regional and National authority for CH protection.

The **Serbian** team collected the contacts of the potential respondents by having in mind the number of facilities of all three target groups. From the very beginning, there was a fear that the final dataset will not contain a representative number of higher education professionals involved in teaching GIS. Namely, pure GIS studies are underdeveloped in Serbia and the lack of tailor-made GIS curricula is noticeable. Therefore, the effort was put to challenge this issue by focusing on technical faculties and faculties of geography and archaeology. On the other hand, as expected, the results in two other categories are satisfactory. In planning and conducting the survey, care was taken to ensure an even regional distribution, even though the final results do not show the expected outcome. As foreseen, personal networks proved to have a great impact on the data collection process. Nevertheless, the professionals from all three groups showed great enthusiasm and even a self-initiative to further disseminate the questionnaire.

The **Slovenian** team identified the potential respondents by collecting the publicly available contacts and via various mailing lists, umbrella organizations, and newsletters of relevant institutions. For both types of teachers, the institutional websites of all Slovenian universities and postgraduate schools were scanned for teachers dealing with GIS and/or cultural heritage. The database was enriched with mentors of the diploma theses with keywords GIS and/or cultural heritage. The CH experts were reached through various mailing lists, umbrella organizations, and newsletters of relevant institutions such as Institute for the Protection of Cultural Heritage of Slovenia, Ministry of Culture, Društvo Asociacija, Creative Europe Desk Slovenia, Centre for Creativity, municipalities, statistical regions, and national registries of museums, libraries, galleries, and archives.

The **Spanish** team identified the respondents based on direct inquiries and internet searches. First, various interviews were conducted with teachers from different Higher Education Centres specialised in GIS or cultural heritage (in a broad spectrum). Second, a systematic search was undertaken through the internet portals of Spanish public face-to-face Universities to identify those that offer degrees in geography, history, art history and humanities. Subsequently, studies in architecture and anthropology were added. They were joined by the UNED (National Distance Education University), which offers distance classes. The study programs of the degrees were reviewed to identify both, GIS and cultural heritage teachers. At the postgraduate level, the same search was carried out to identify the offer of masters' degrees or postgraduate programs in Geographic Information Systems with different orientations. The Higher Council for Scientific Research (CSIC), an institution focused on research but that also provides specialized training courses, was also included. With regard to CH experts, some associations such as the Spanish Geography Association (AGE) and one Association of Cultural Managers disseminated the questionnaire among their members. The AGE sent the questionnaire to the associates of two working groups: the Geographical Information Technologies Group and the

Geography Didactics Group. The remaining experts were identified through the publicly available directory of organizations dedicated to culture in Spain (archives, libraries and museums, among others) that is compiled in full on a national and regional scale.

The questionnaire was released to all three target groups in all six countries on 22nd December 2020. After two weeks, a reminder was sent to all potential respondents. The survey was terminated on 22nd January. We received 743 answers in total. After a detailed **data cleaning** process, **649 valid answers** were accepted for a final analysis.

2.2 RESULTS

2.2.1 Identification of target groups

The first task for the respondents was a self-identification with one of the three target groups. They had to select whether they predominantly work as 1) teachers of geographic information systems in higher education (GIS teachers), 2) teachers of cultural heritage in higher education (CH teachers), and 3) professional individuals or staff members in an institution dealing with cultural heritage (CH experts).

The majority of responses come from CH experts (63%), while CH teachers (20%) and GIS teachers (16%) represent slightly smaller groups (Table 2). Respondents are relatively evenly distributed across all partner countries (France, Greece, Italy, Serbia, Slovenia, and Spain), with some areas with higher concentration of responses (e.g., capitals and other large cities) (Fig. 1). Both types of teachers work at numerous (88) higher education institutions across participating countries (Table 3).

Table 2: Structure of respondents by participating countries and target groups.

Country	GIS teachers	CH teachers	CH experts	Total
France	16	5	7	28
Greece	17	6	45	68
Italy	11	22	49	82
Serbia	5	23	60	88
Slovenia	9	17	141	167
Spain	48	60	108	216
Total	**106**	**133**	**410**	**649**

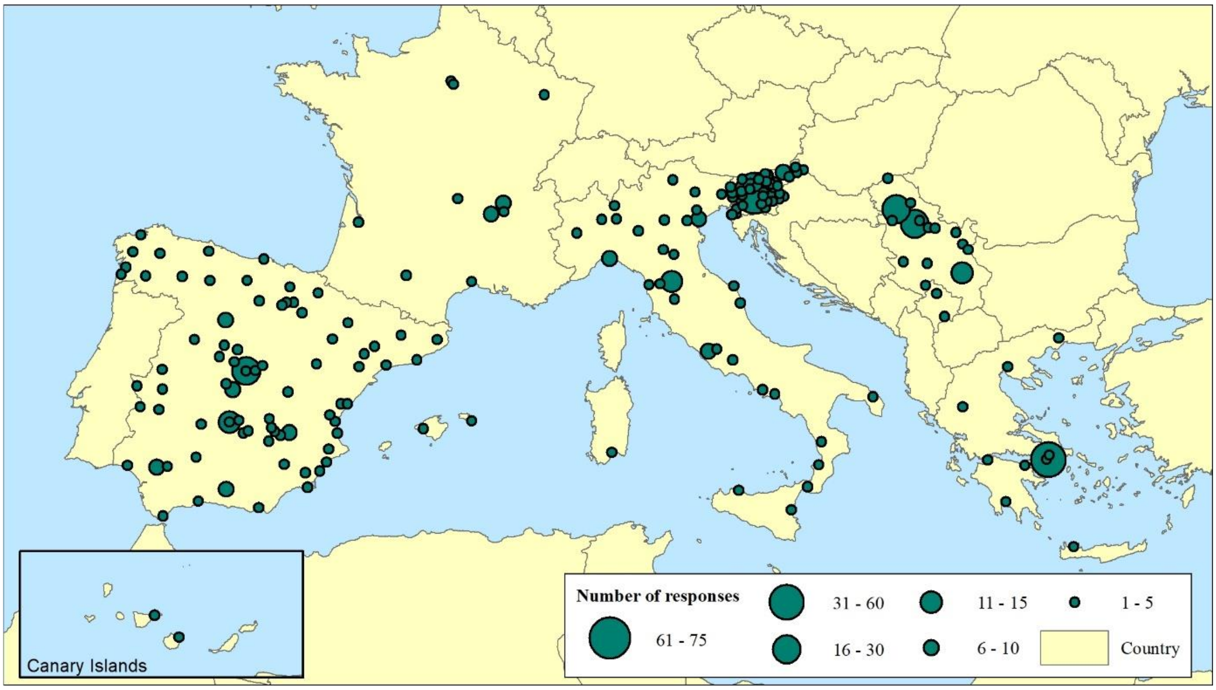


Figure 1: Distribution of respondents by participating countries.

Table 3: List of higher education institutions of GIS and CH teachers by participating countries.

France
Université Jean Monnet
Université Jean Moulin Lyon 3
Université Bordeaux Montaigne
ENS de Lyon
Lycée Agrotec de Vienne
Mines Saint-Étienne
Toulouse Jean-Jaurès
Université de Lorraine
Université de Paris
Université Lumière - Lyon2
Université Paris XII Créteil
VetAgroSup

Greece
National Technical University of Athens
Harokopio University
National and Kapodistrian University of Athens
University of Thessaly
University of West Attica
Athens University of Economics and Business
Technical University of Crete
University of the Aegean

Italy
Università degli Studi di Padova
Università degli Studi di Firenze
Università Iuav di Venezia
Università degli Studi di Salerno
Università di Trieste
Università Ca’ Foscari
Sapienza Università di Roma
Università degli studi di Cagliari
Università degli Studi di Milano
Università degli Studi di Udine
Università degli Studi di Verona
Università del Piemonte Orientale
Università della Calabria
Università di Bologna
Università di Catania
Università di Genova
Università di Modena e Reggio Emilia
Università di Roma Tor Vergata
Università di Siena
Università di Verona
Università Roma Tre

Serbia
University of Niš
University of Belgrade
University of Novi Sad
University of Priština - Kosovska Mitrovica
University "MB" Belgrade

Slovenia
Univerza v Ljubljani
Univerza na Primorskem
Univerza v Mariboru
Podiplomska šola ZRC SAZU

Spain
Universidad de Castilla-La Mancha
Universidad Nacional de Educación a Distancia
Universidad de Valladolid
Universidad de Granada
Universidad de Sevilla
Universidad de Alicante
Universidad de Murcia
Universitat de Lleida
Universidad Complutense de Madrid
Universidad de Málaga
Universidad de Zaragoza
Universidade de Santiago de Compostela
Universitat de Girona
Universitat Politècnica de València
Universidad Autónoma de Madrid
Universidad de Cantabria
Universidad de La Laguna
Universidad de La Rioja
Universidad de Las Palmas de Gran Canaria
Universidad de Oviedo
Universidad de Salamanca
Universidad Politécnica de Cartagena
Universitat de Barcelona
Universitat Rovira i Virgili
Colegio Santa María del Pilar
Universidad Autónoma de Barcelona
Universidad de Alcalá de Henares
Universidad de Burgos
Universidad de Extremadura
Universidad de León
Universidad de Lleida
Universidad de Santiago de Compostela
Universidad del País Vasco
Universidad Nebrija
Universidad Politécnica de Valencia
Universidad Rey Juan Carlos
Universitat Jaume I

Most CH experts are employed in the public sector (78%), while only a small proportion are employed in the private sector (14%) (Table 4). The majority of CH experts work in institutions known as GLAM - Galleries, Libraries, Archives, Museums (41%), and authorities at different spatial levels (22%). There is also a significant share of respondents working in companies, NGOs, research institutes and being self-employed (Table 5). Most CH experts work in SMEs (10-249 employees; 61%), followed by micro enterprises (< 10 employees; 27 %) and large institutions (+250 employees; 12%).

Table 4: Structure of CH experts according to the type of sector they work at.

Type of sector	N	Share
Public	321	78%
Private	58	14%
Other	17	4%
Unknown	14	3%
Total	**410**	**100%**

Table 5: Structure of CH experts according to the type of institution they work for.

Type of institution	N
Museum	92
Archive	33
Library	37
Art gallery	5
National agency for CH protection	23
National authority (e.g. ministries)	18
Regional agency for CH protection	25
Regional authority	13
Local authority (e.g. municipality)	12
Company	15
NGO	17
Research institute	39
Self-employed	25
Other	48
Unknown	8
Total	**410**

The background of GIS teachers is predominantly in geography (70%) and then followed by other spatial disciplines such as urban and regional planning, natural sciences, urbanism, architecture, geodesy, landscape architecture, civil engineering, and engineering and technology (Fig. 2). Both CH target groups (teachers and experts) have a very diverse background such as archaeology, history, conservation, cultural tourism, geography, art history, museology, architecture, ethnology, art, restoration, cultural studies and anthropology (Fig. 3). However, there are some significant differences between the two groups. The background of CH teachers is more common in some classical disciplines already taught in secondary education, such as geography, history, and art history, whereas CH experts are more often specialized in disciplines taught only in higher education such as archaeology, conservation, museology, ethnology, and restoration.

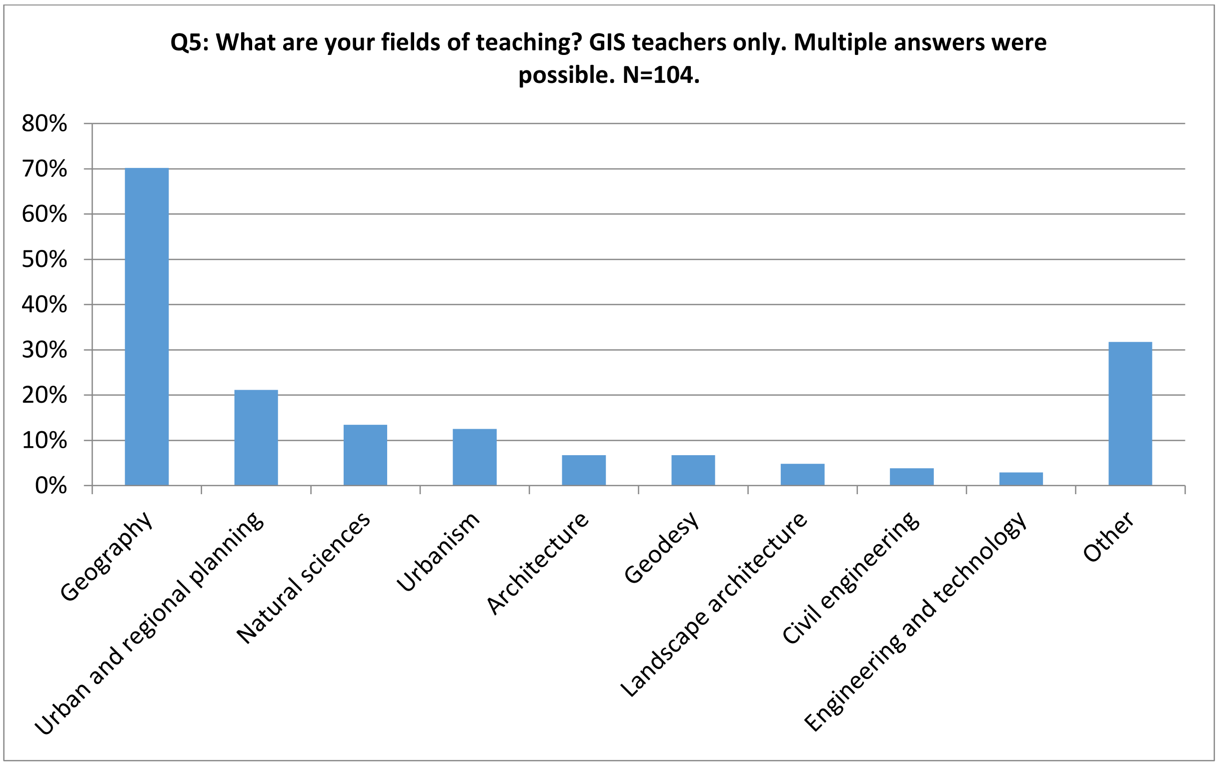


Figure 2: Background of GIS teachers.

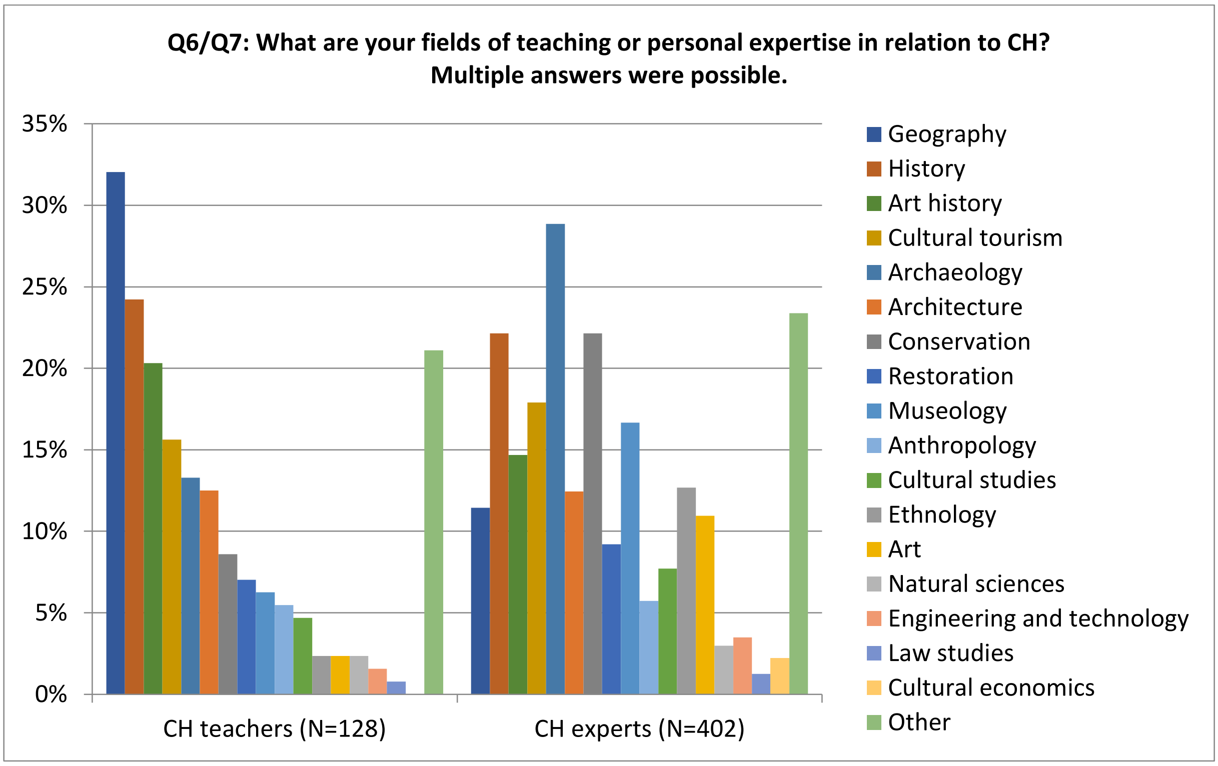


Figure 3: Background of CH teachers and CH experts.

Both CH target groups (teachers and experts) are significantly focused on all fields of cultural heritage, such as analysis, identification (e.g. evaluation, mapping), promotion (e.g. tourism, local and regional development), management, preservation, restoration, protection (formal, law) (Fig. 4). However, CH teachers are more focused on CH analysis, while CH experts more often deal with CH preservation, restoration, and protection (formal, law).

The demographic indicators show that while there is almost a gender balance in the surveyed group of CH teachers, a subtle gender imbalance in the surveyed group of CH experts is detected (with a skew towards more female for CH experts) and a gender imbalance is present in the surveyed group of GIS teacher (with almost 70% being male and about 30% being female) (Fig. 5)[2]. A large majority of all three target groups are middle-aged. There is a surprisingly low share of young people included in each target group (Fig. 6). As expected, both groups of teachers hold predominantly a doctoral level of education, while most of CH experts still have a tertiary education, but are more evenly distributed among holders of degree, master and PhD (Fig. 7).

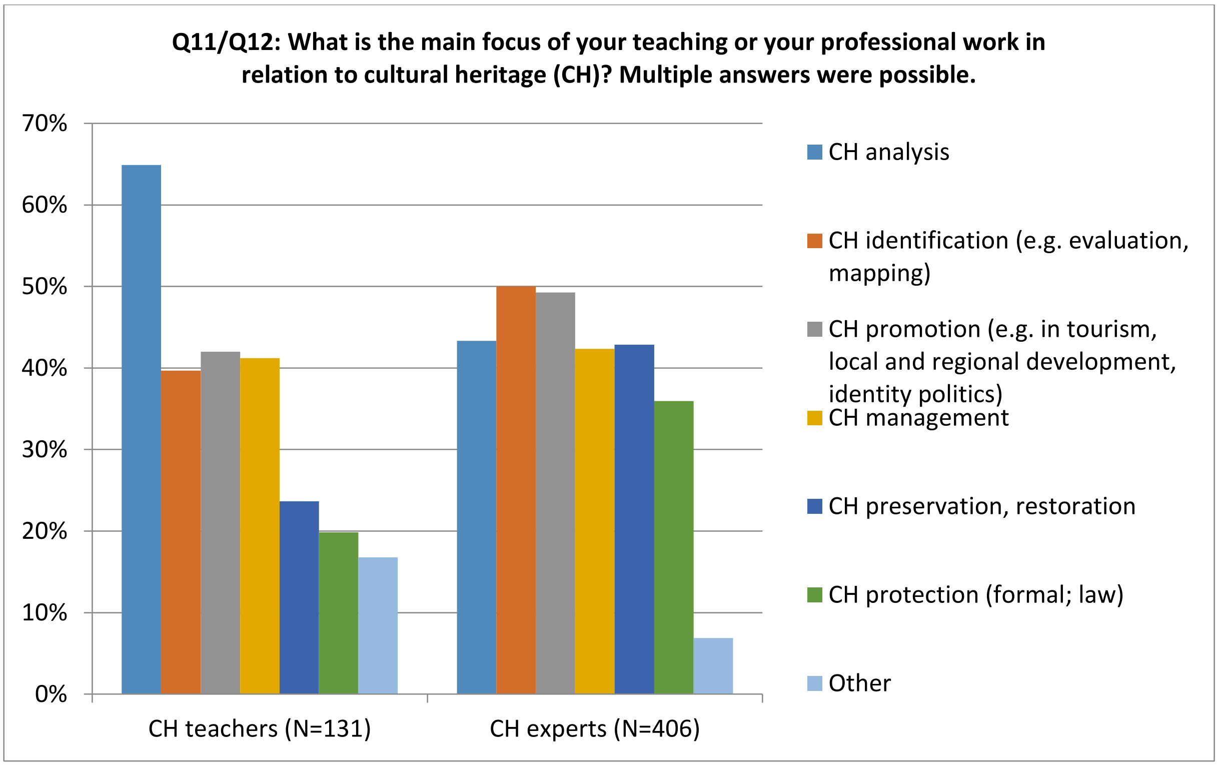


Figure 4: Focus of CH teachers and CH experts in different fields of cultural heritage.

[2] It is important to address the gender imbalances/gaps throughout the different tasks of the Minerva project, also to foresee whether the utilization of the MOOC maybe has to redress gender imbalance (there are some initial studies on gender imbalance in MOOCs – see e.g. Jiang et al., 2018), as the Erasmus+ Programme aims at fostering gender balance and gender equality (see ERASMUS+ Programme Guide).

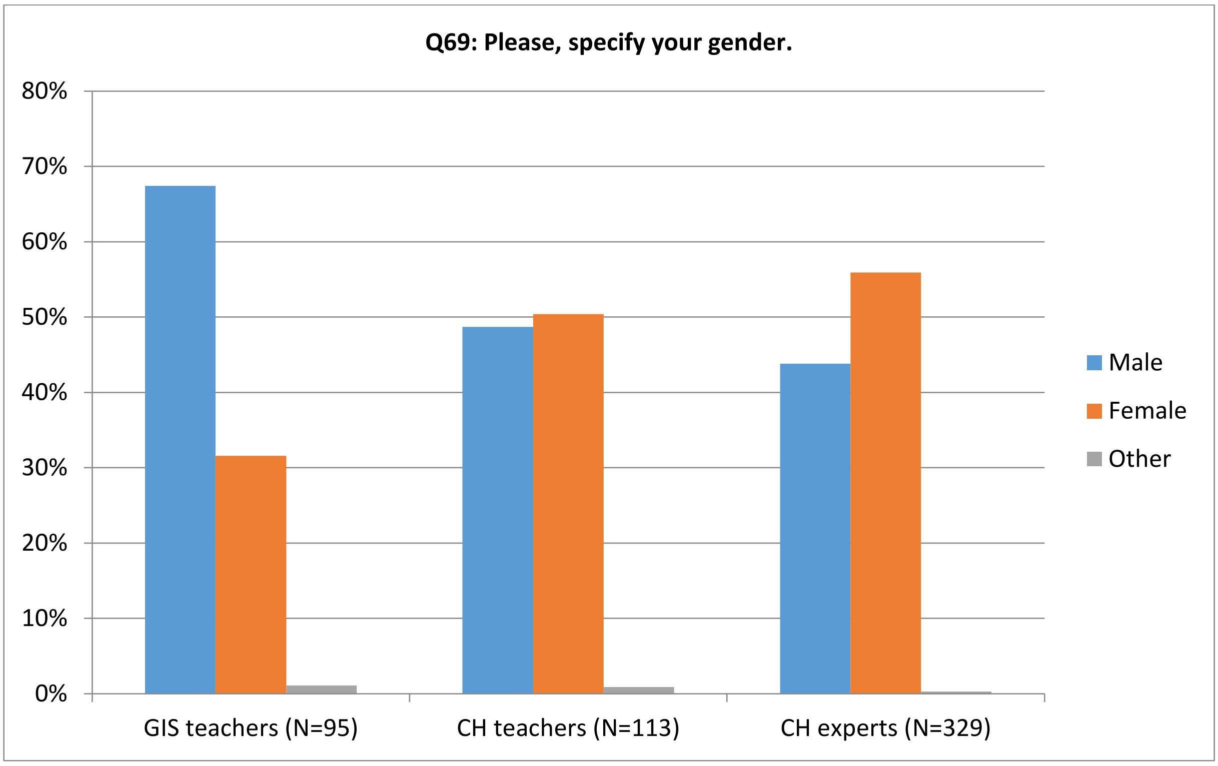


Figure 5: Gender of respondents.

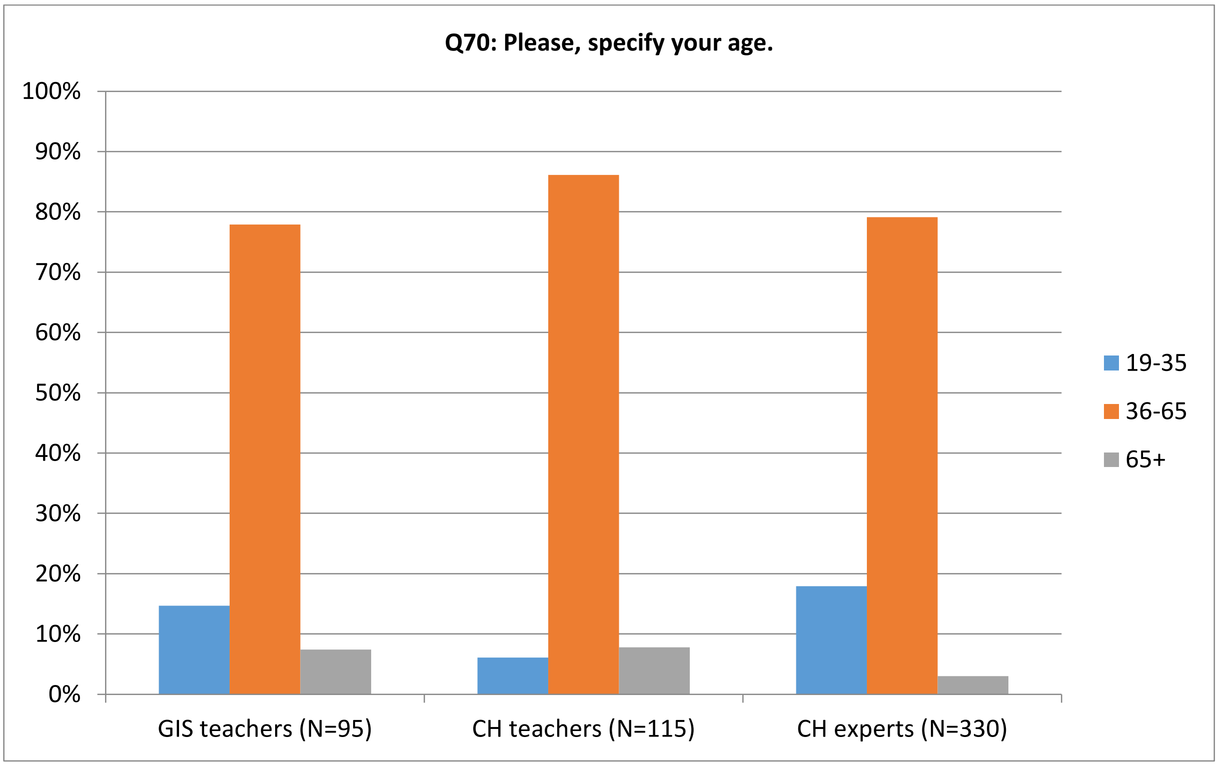


Figure 6: Age of respondents.

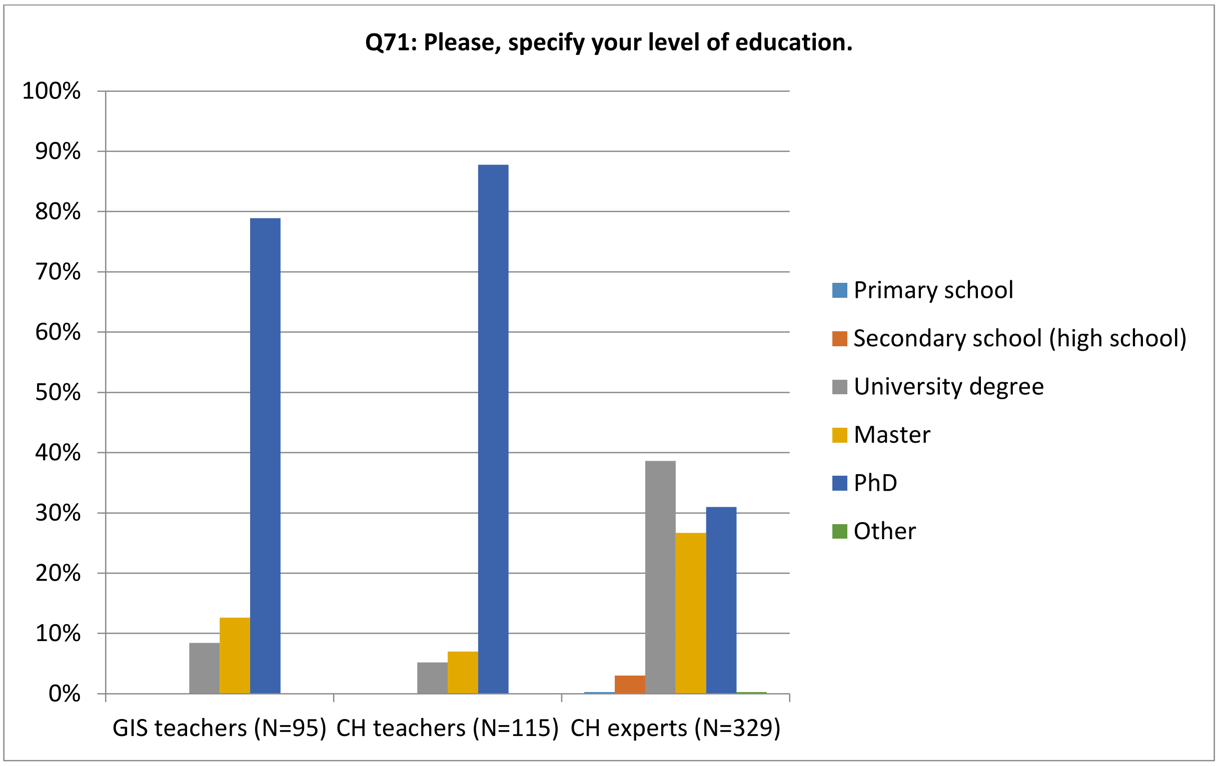


Figure 7: Level of education of respondents.

2.2.2 Basic characteristics of GIS involvement

This chapter provides a basic overview on involvement of three target groups into GIS. The results highlight how the respondents generally value the importance of teaching and practicing GIS for cultural heritage, their actual involvement of using GIS in teaching and professional work, and their main sources for teaching GIS.

Before continuing by answering specific questions on GIS, both CH target groups (teachers and experts) were asked a question about their familiarity with the topics of GIS (Fig. 8). Most respondents know exactly what it is about or have at least some basic knowledge about it, although CH teachers are slightly more aware of GIS compared to CH experts. However, only 7% of both types of respondents did not know what GIS meant at the time of the survey. To eliminate this basic barrier, respondents whose knowledge of GIS is not complete were kindly invited to watch a brief GIS presentation[3] before answering certain GIS questions. The presentation provided the following short definition of GIS: *"The most common explanation of geographic information systems involves hardware (equipment) and software tools for processing spatial data at various spatial levels:* ***data acquisition*** *(collecting, assembling),* ***data management*** *(storing, retrieving at will),* ***data analysis*** *(manipulating, transforming),* ***data visualization*** *(displaying)."* The presentation was accompanied by illustrative examples and was given in the national languages of the respondents (i.e., Greek, French, Italian, Serbian, Slovenian, Spanish).

Generally, respondents from both CH groups (teachers and experts) value the importance of teaching/practicing GIS for cultural heritage quite highly. On a scale from 1 - not important at all to 5 - very important, no field of cultural heritage was on average rated with less than 4 - important (Figs. 9 and 10). However, the highest importance was recognized in relation to CH identification (e.g. evaluation, mapping) and a bit lower in relation to categories of preservation, restoration, and protection (formal, law).

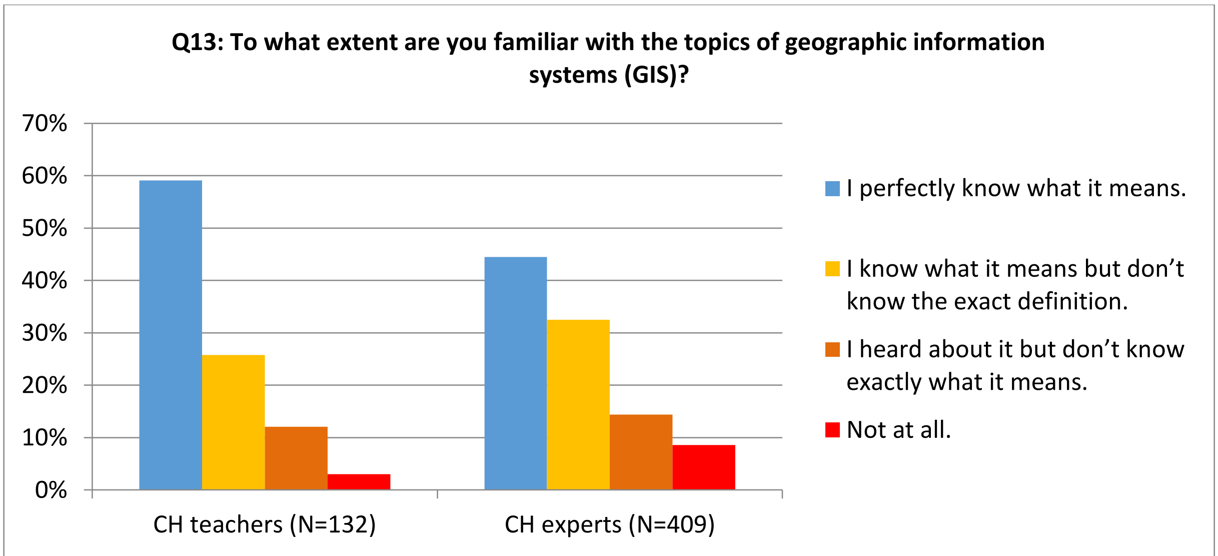


Figure 8: Familiarity of CH teachers and CH experts with GIS.

[3] https://www.youtube.com/watch?v=-E50qL_HFeA

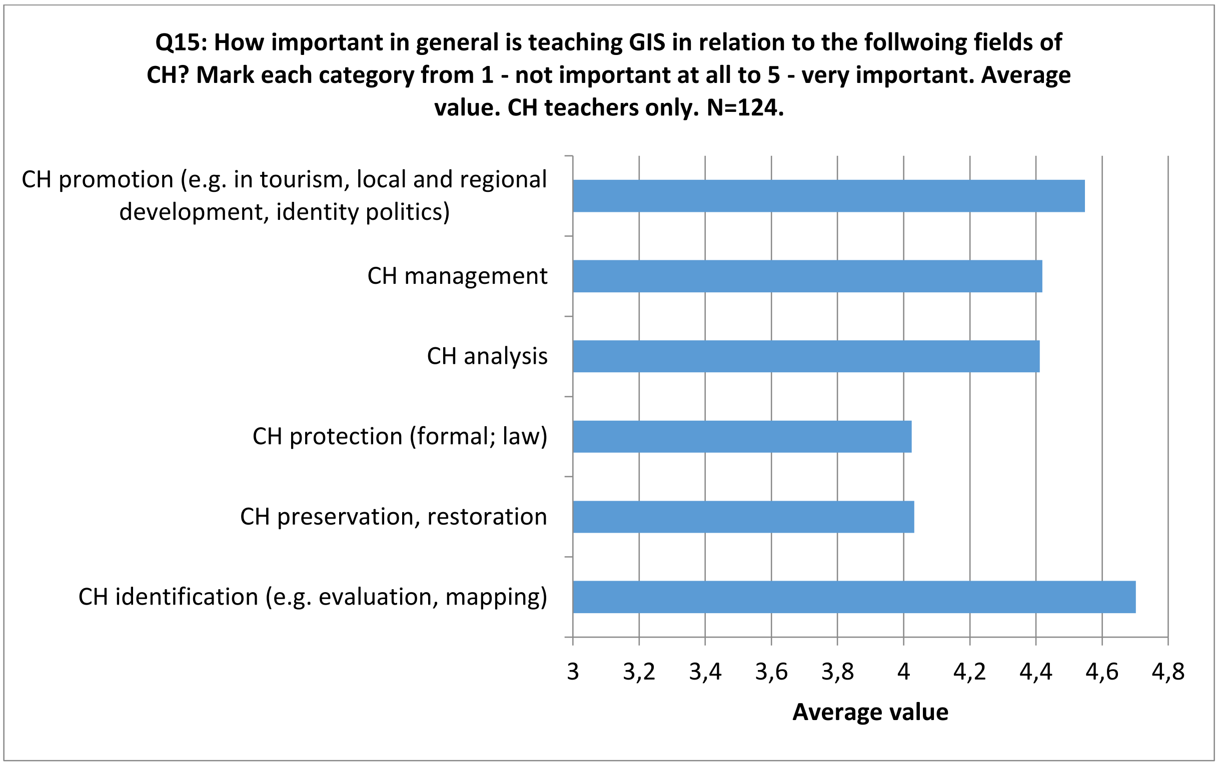


Figure 9: Importance of teaching GIS for cultural heritage.

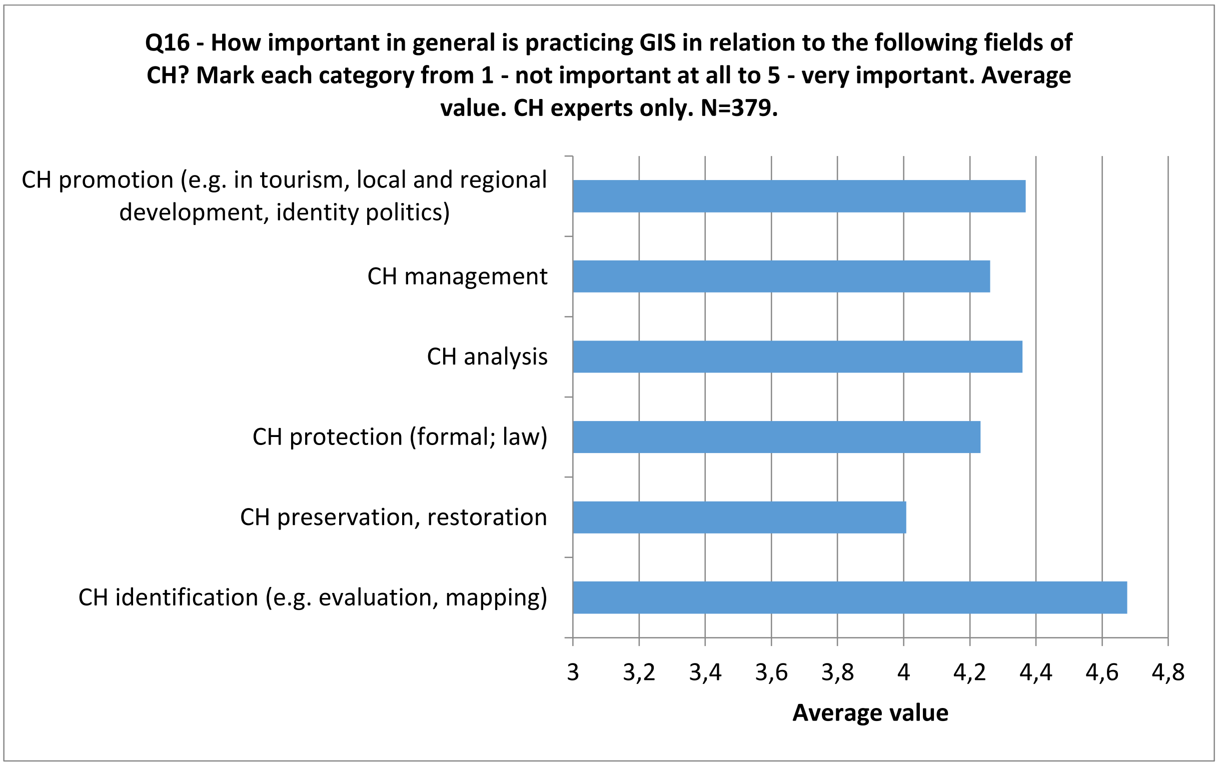


Figure 10: Importance of practicing GIS for cultural heritage.

Respondents from both CH groups (teachers and experts) also behave similarly when it comes to using GIS for their actual teaching and professional work. Although both groups see the importance of GIS for different areas of cultural heritage, about 60% of them never or rarely use GIS (Fig. 11). As evident from the word cloud, CH experts that use GIS in their professional work most often apply simple tasks of using the spatial databases (e.g., identification, data acquisition and analysis, cartography, mapping, management). Some respondents also employ more sophisticated tasks such as photogrammetry, georeferencing, and modelling (Fig. 12).

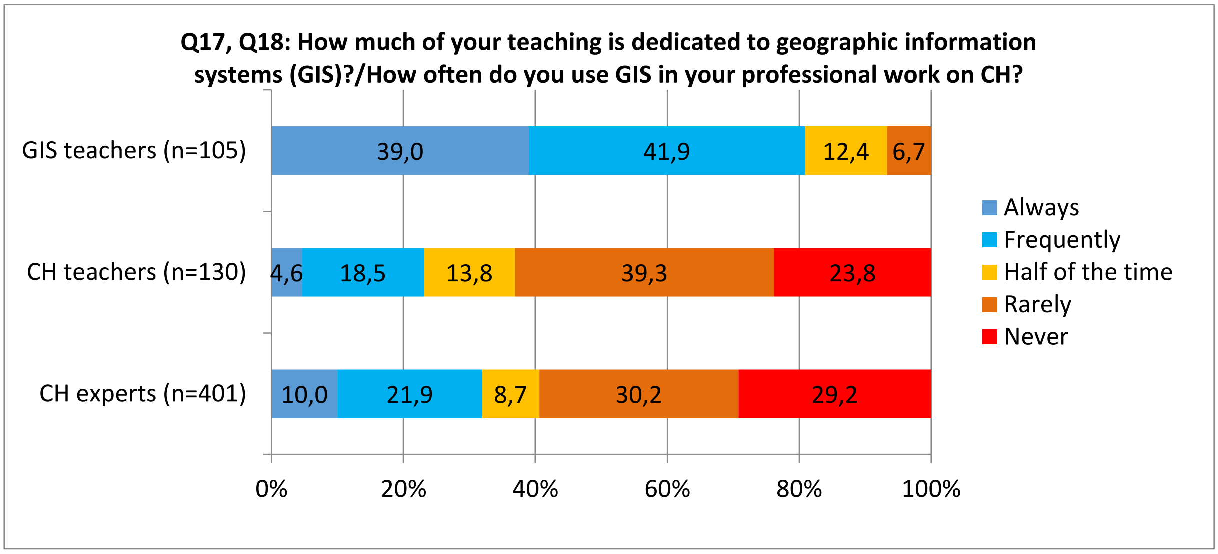


Figure 11: Frequency of using GIS in teaching and professional work.

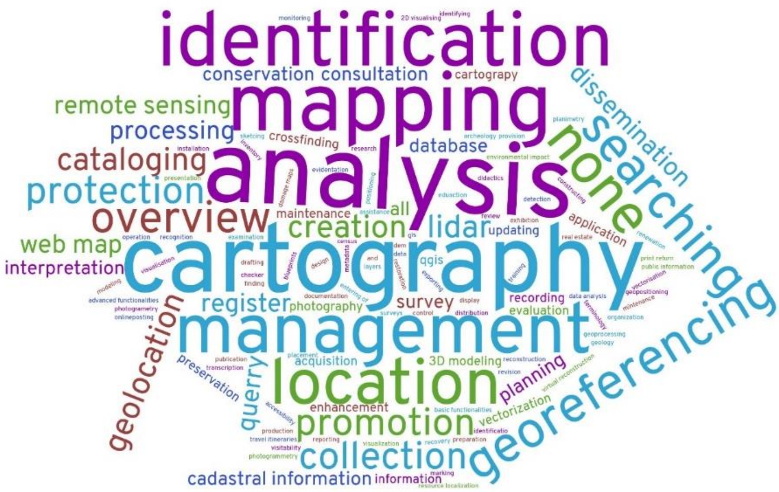


Figure 12: Word cloud presenting tasks that CH experts perform on their own.

As expected, there is a big divergence between both CH groups and GIS teachers, who use GIS very often in teaching. More than 80% of the latter group always or frequently use GIS (Fig. 11). In contrast, GIS teachers are less familiar with the topics of cultural heritage. More than two thirds (68%) never or rarely address cultural heritage in their teaching. As expected, this share is among CH teachers significantly lower (less than 10%) (Fig. 13).

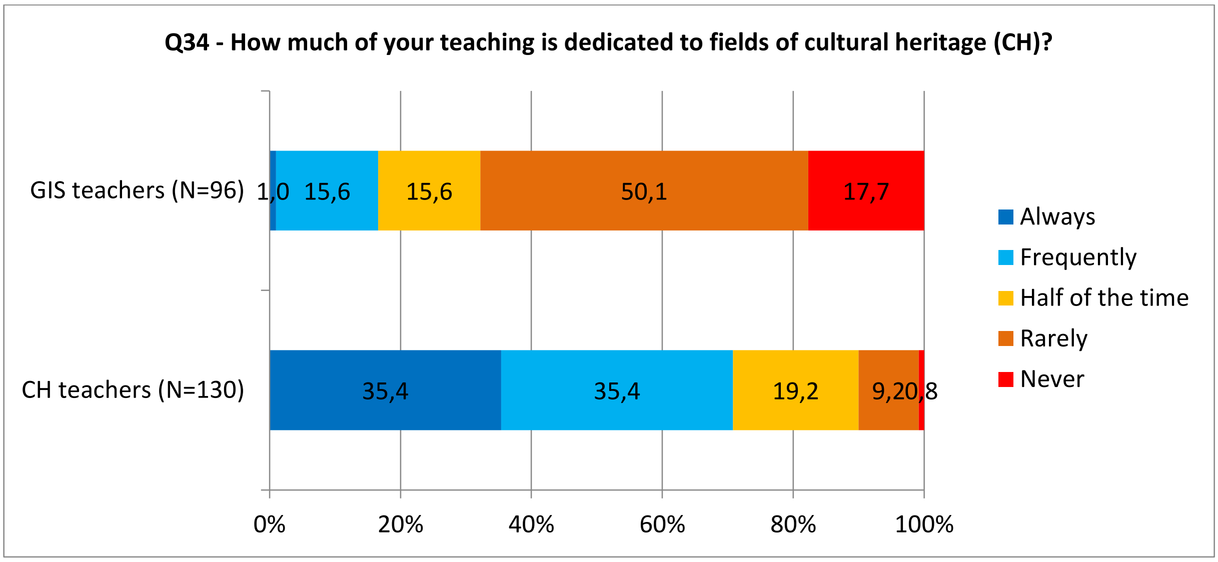


Figure 13: Frequency of addressing cultural heritage in teaching.

There is also a significant contrast between GIS teachers and CH teachers in the perceived amount of time dedicated to GIS in teaching. More than half of CH teachers estimate the amount of time dedicated to teaching GIS as insufficient, while the share of such GIS teachers is around a third (Fig. 14).

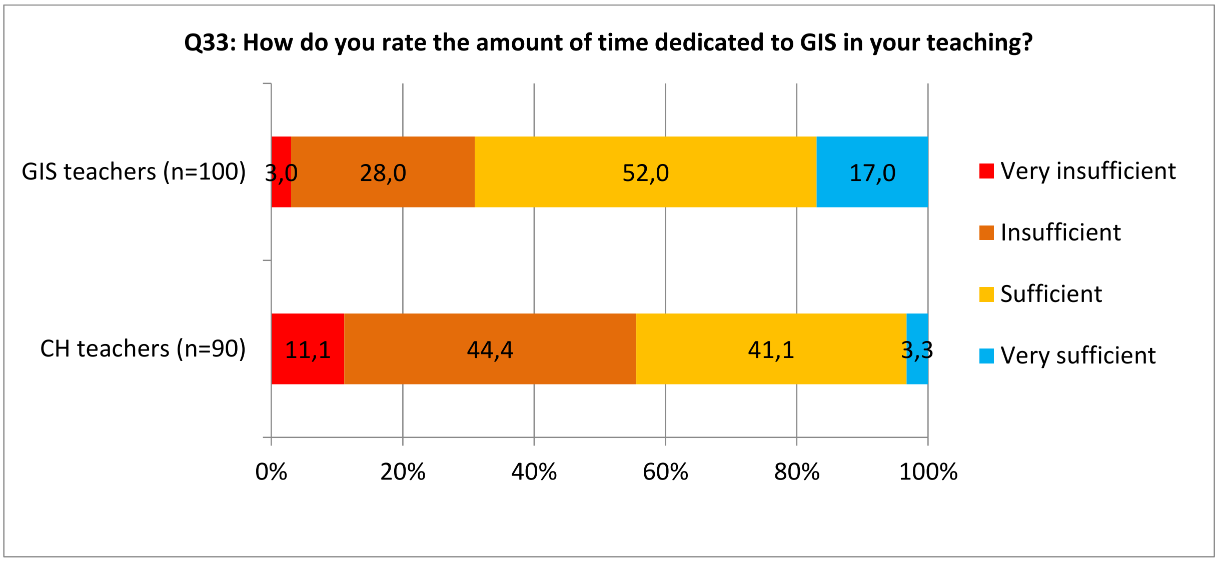


Figure 14: Sufficiency of time dedicated to GIS in teaching.

Both CH groups have significant needs for external GIS support to enrich their teaching and professional work on cultural heritage (Fig. 15). We have noticed that CH teachers and experts outsource tasks from all stages of GIS (e.g., acquisition, analysis, visualization). Most often, they need support for mapping and other tasks such as digitization, georeferencing, data analysis, and 3D modelling. GIS teachers often mentioned a need for external support when it comes to using specialised equipment (e.g., drones) or advanced techniques (e.g. statistical analysis, remote sensing and modelling) (Fig. 16).

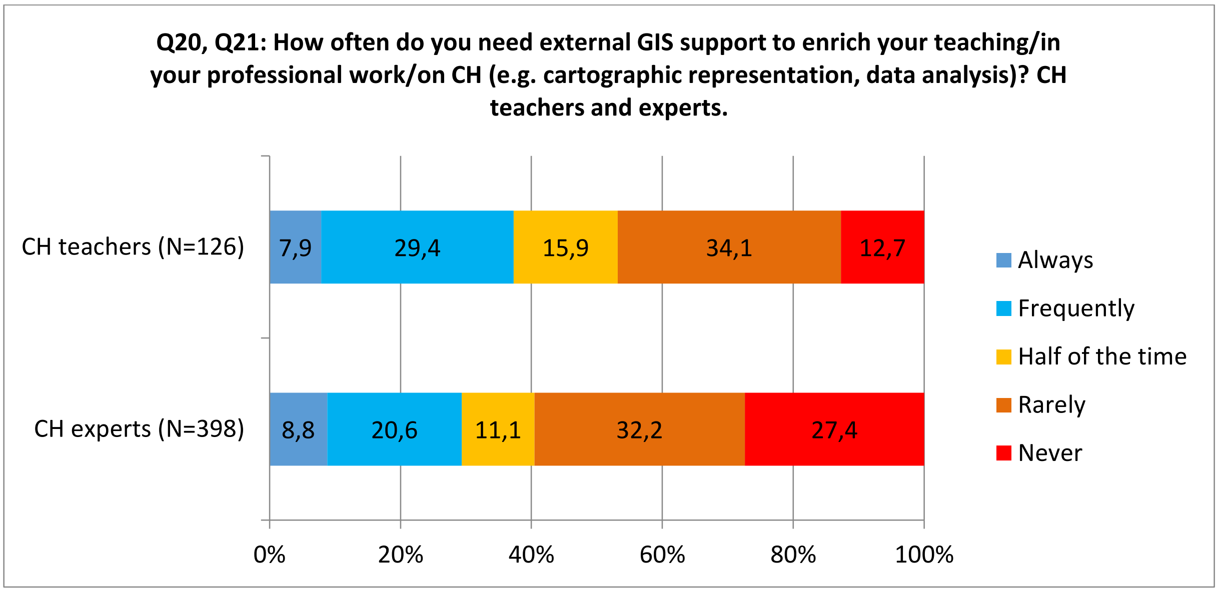


Figure 15: Needed external GIS support in teaching and professional work on cultural heritage.

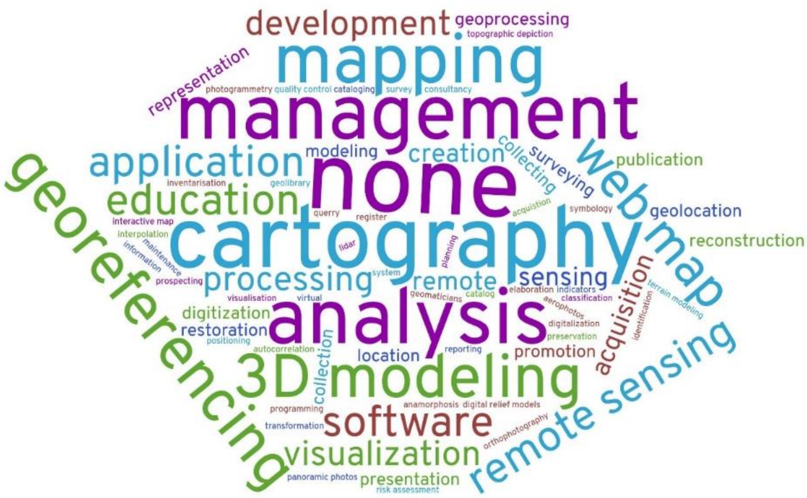


Figure 16: Word cloud presenting tasks that respondents outsource.

Such results indicate a great potential of collaboration between GIS teachers and members of both CH groups. The lessons and skills of GIS teachers could be more often integrated into the curricula of different disciplines that teach cultural heritage in higher education and then transferred to the labour market, which deals with cultural heritage.

When looking at the main sources for teaching GIS among both groups of teachers some interesting results occurred (Fig. 17). The most utilized category is 'learning by doing' where teachers put a lot of emphasis on practical work and illustrative-demonstrative methods. A typical example is to repeat an exercise explained in a classroom and do it in another study area and with other parameters. This type of education quite often includes self-learning via online material and/or software packages. Teachers sometimes also include students in concrete projects. Learning by doing is then followed by the categories of 'textbooks' and 'tutorials'. The latter category most often includes tutorials of specific software packages such as ESRI ArcGIS and QGIS, short videos on YouTube and tutorials designed by teachers themselves.

Online courses that are in particular interest of the MINERVA project represent a less important source for teaching GIS. Only about one third of GIS teachers and one fifth of CH teachers mentioned this category as a source for teaching GIS (Fig. 17). This fact may indirectly indicate a need to develop such tools to be used by teachers and learners. Table 6 provides a list of online courses used by respondents in teaching GIS.

GIS teachers quite often involve GIS into different educational forms, although there is some potential in the category "e-lessons/online courses" as other conventional methods prevail (Fig. 18). However, CH teachers significantly less often include GIS into any kind of educational forms with the category "e-lessons/online courses" also being the least utilized. Almost 75% of CH teachers never or rarely use e-lessons/online courses to teach students GIS (Fig. 19).

When it comes to teaching fields of cultural heritage, the outlook is expectedly pretty much the opposite. GIS teachers teach cultural heritage significantly less than CH teachers by all educational forms. However, both types of teachers more often use conventional forms of education in comparison to the category "e-lessons/online courses" (Figs. 20 and 21).

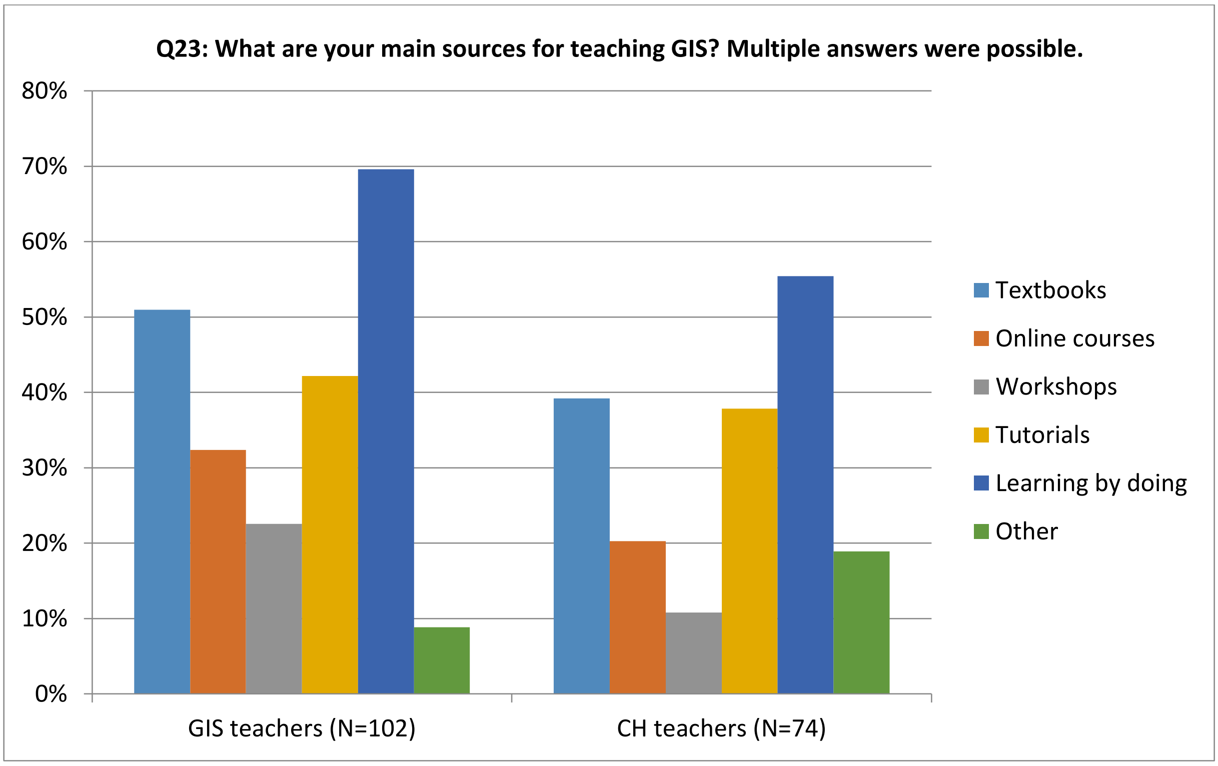


Figure 17: Main sources for teaching GIS.

Table 6: Online courses used for teaching GIS as mentioned by GIS and CH teachers.

Online course	URL
Courses of Mappinggis	https://mappinggis.com
UNIGIS GIRONA online training program	https://www.unigis.es
UNED	https://www.uned.es/universidad/inicio.html
Cartographie thématique	https://fr.coursera.org/learn/cartographie
Master's degree in GIS Applied to Landscape, Urbanism and Landscape	https://www.cfp.upv.es/formacion-permanente/curso/master-sistemas-informacion-geografica-aplicados-ordenacion-territorio-Urbanism-paisaje_69167.html
IMASGAL Technique	https://imasgal.com
Introduction to ArcGIS for Archaeologists	https://www.le.ac.uk/ar/arcgis/Main.html
Basics for Archaeologists using ArcMap and ArcGIS	https://www.esri.com/training/catalog/5ca3d039c7df424bb95f441b/basics-for-archaeologists-using-arcmap-and-arcgis
ArcGIS in Archaeology: Working with 3 Dimensions	https://sandbox.idre.ucla.edu/sandbox/arcgis-in-archaeology-working-with-3-dimensions
Processing and Working with LiDAR Data in ArcGIS: A Practical Guide for Archaeologists	https://orca.cf.ac.uk/85324/1/259.pdf
Introduction aux systèmes d'information géographiques avec QGIS	http://www.geotests.net/cours/qgis/fr
Bibliothèque de ressources pédagogiques de l'ENSG École Nationale des Sciences Géographiques	http://cours-fad-public.ensg.eu
QGIS - Formations et supports pédagogiques	http://www.geoinformations.developpement-durable.gouv.fr/qgis-formations-et-supports-pedagogiques-r947.html
Systèmes d'Information Géographique	https://www.coursera.org/learn/intro-sig-1
Le SIG comme outil d'aide à la décision : étude de cas pour une localisation optimale d'un écocomplexe touristique	http://www.emse.fr/tice/uved/SIG/Ecocomplexe
Tutoriel QGIS 3.16	https://ouvrir.passages.cnrs.fr/tutoqgis/index.php
Glossaire de la géomatique, des SIG et du géoweb	http://www.univ-st-etienne.fr/wikimastersig/doku.php/glossaire:accueil
ESRI ArcGIS Courses	https://www.esri.com/training/
Courses of the Colegio de Geógrafos of Andalusia	https://andalucia.geografos.org/
Courses of GeoInnova	https://geoinnova.org/
Courses of IGN (Instituto Geográfico Nacional)	https://Courses.cnig.es/
Courses de gvSIG	https://blog.gvsig.org/2019/09/24/aprender-sig-con-Courses-online-gratuitos-y-software-libre/
Course on geolocation and social networks	https://www.youtube.com/watch?v=XT-niV-HMs4&list=PLc-nlLBFUXijJjSHr9Lbl3t-vwJyrAwM

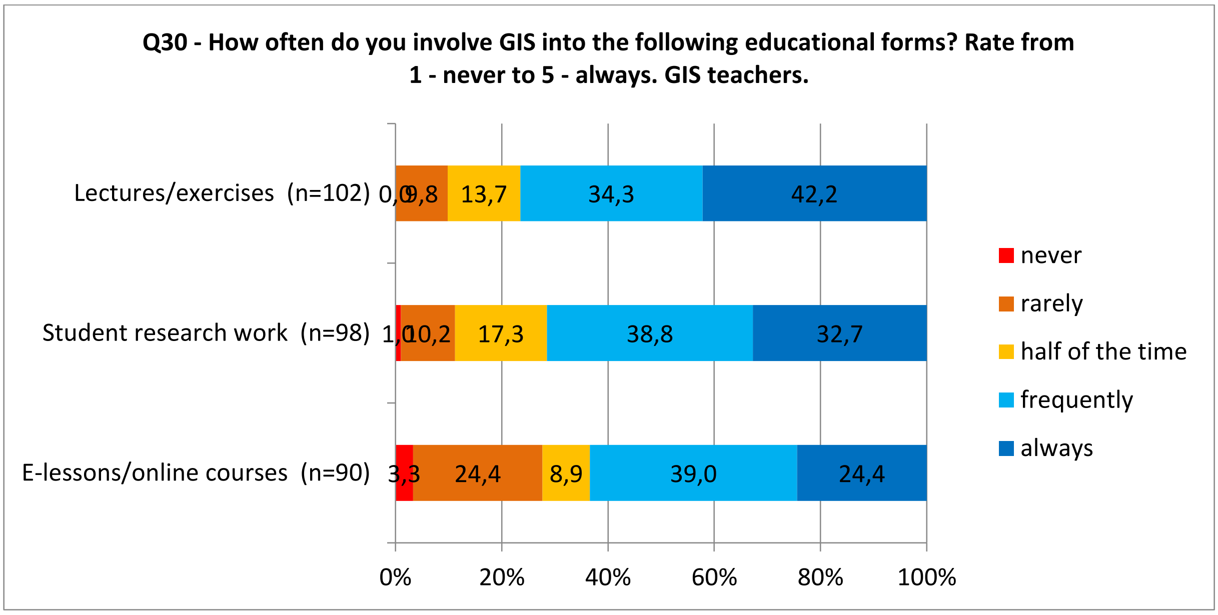


Figure 18: The frequency of teaching GIS in different educational forms among GIS teachers.

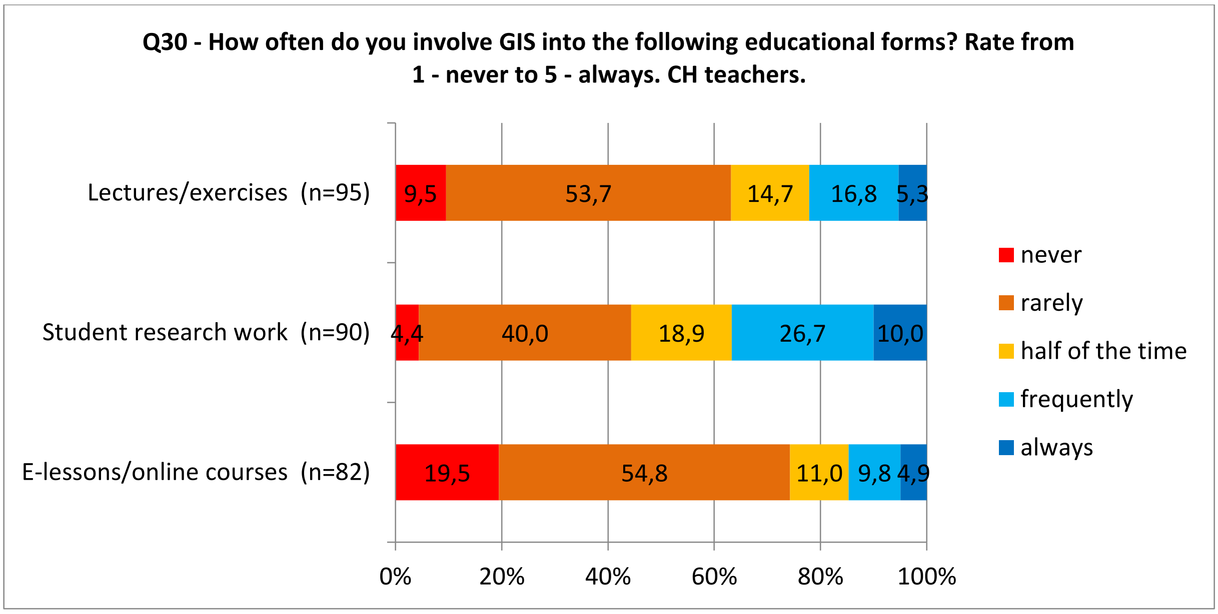


Figure 19: The frequency of teaching GIS in different educational forms among CH teachers.

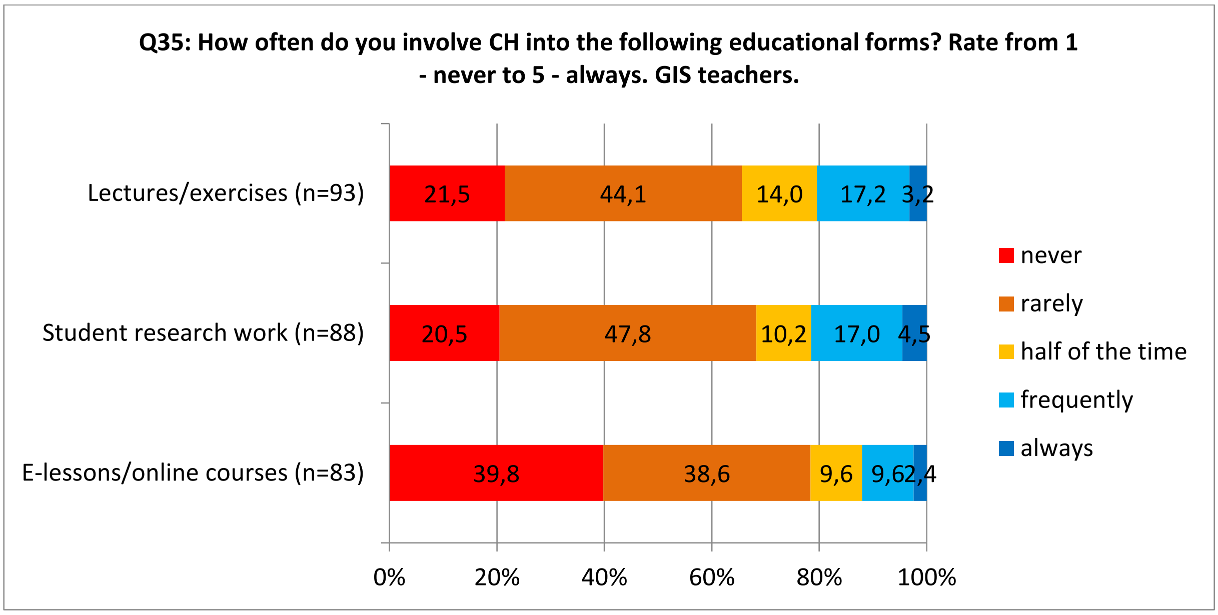


Figure 20: The frequency of teaching CH in different educational forms among GIS teachers.

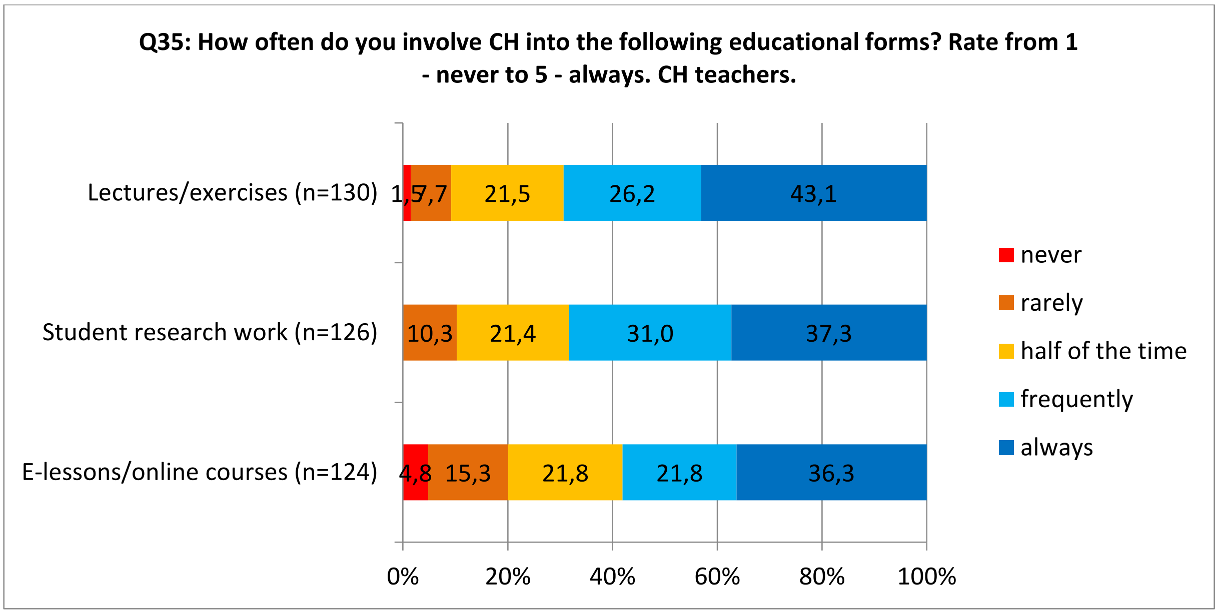


Figure 21: The frequency of teaching CH in different educational forms among CH teachers.

2.2.3 Usage of hardware and software equipment

In the hardware and software usage section, we analyse what kind of equipment and computer programs do institutions use. Namely, in the field of GIS there are diverse methodological approaches available for achieving certain goals. For example, a map can be produced by using commercial or open-source software and later printed with several types of printers. To evaluate the compatibility of the education system (GIS and CH teachers) with the needs of the labour market (CH experts), it is therefore very important to simultaneously analyse the usage of hardware and software in both spheres.

When it comes to hardware, desktop computers are still the most common tool used by all three target groups (GIS teachers, CH teachers, and CH experts). The probable reason is that powerful desktop computers are needed for geoinformation tasks. Other, more frequently used tools are phones, tablet computers and GNSS devices (the order varies according to the specific target group!). GIS teachers more often use GNSS devices, CH teachers often use tablet computers, and CH experts often use phones (Fig. 22).

It has to be noted that drones are quite often used by CH experts in comparison to other specific GIS devices. Therefore, this field should be involved in educational programs. In the last few years, unmanned aerial vehicles (UAV or drones) are very popular for aerial imagery and production of orthophoto images, digital surface models, etc. Other devices that are also used (but to a lesser extent) by all the groups are laptops, hyperspectral, multispectral or thermal cameras (Fig. 22).

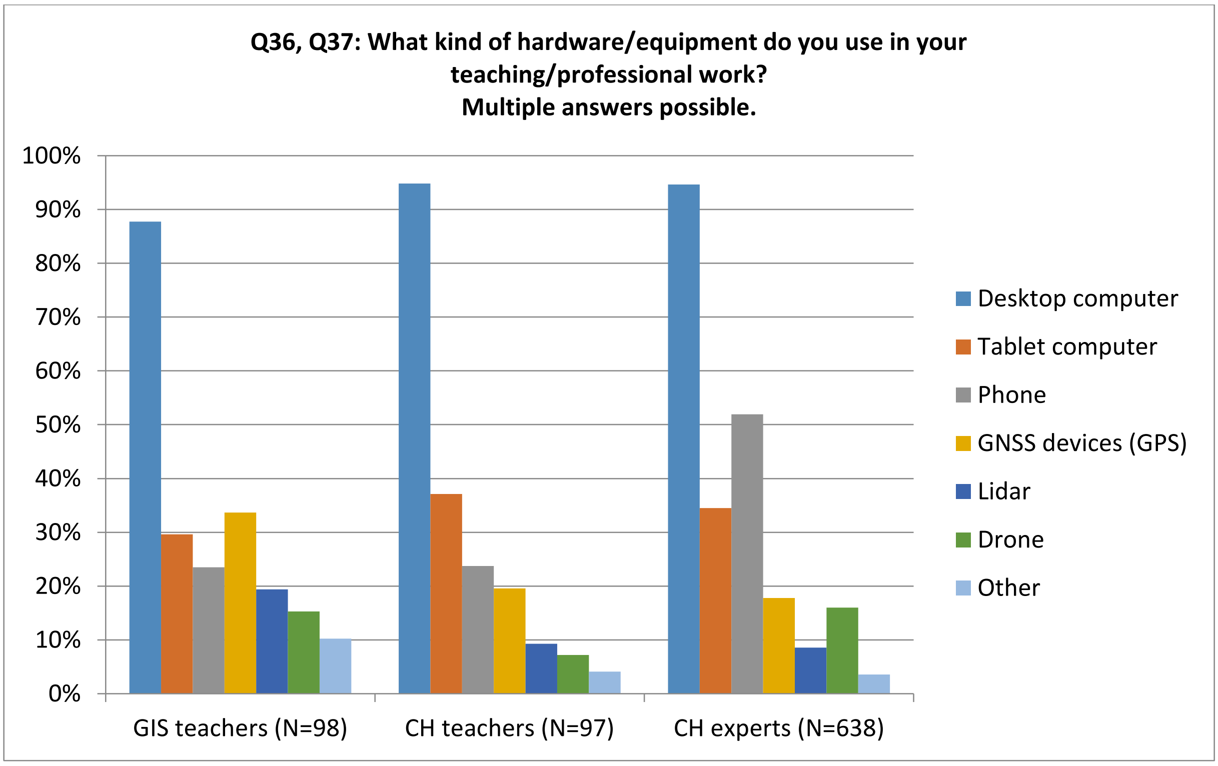


Figure 22: Hardware/equipment usage.

When the question comes to software, a very important thing to examine is the relationship between commercial and non-commercial software packages (desktop programs and web applications). Our investigation (Figs. 23–25) shows that the highest rate of commercial software has been observed for a group of GIS teachers (with approximately 79% of at least rare usage) and the lowest rate has been noticed for a group of CH teachers (with 46% of at least rare usage). The percentage of at least rare usage is also relatively low for CH experts (53%). The usage of non-commercial software is also the highest by GIS teachers (96%), followed by CH experts (86%), and CH teachers with the lowest rate (74%).

One of the reasons for the non-commercial software usage by CH experts might be the different categories of prices of commercial software. Namely, commercial software is usually much cheaper for academic and educational purposes than for commercial profit-based usage. A reason for low usage of commercial software by CH teachers might be the fact that most of them do not need to perform advanced geoinformation tasks and most of freely available software suffice (see also Fig. 11 on the frequency of GIS usage by CH teachers).

According to our study, very common commercial desktop GIS software are products of ESRI (ArcGIS Desktop [ArcMap], ArcGIS Pro), which represent a majority, and followed by Mapinfo, Terrset, GlobalMapper, Autocad and others. The most frequent non-commercial software is QGIS. It represents a vast majority of freely available software solutions.

When it comes to online GIS applications, even higher frequencies of non-usage have been observed for the commercial online GIS applications (in comparison to the desktop software). Commercial online applications are at least rarely used by 56% of GIS teachers, 37% of CH teachers, and 41% of CH experts. The usage (at least rare usage) of non-commercial online applications is much higher (GIS teachers 89%, CH teachers 75%, and CH experts 90%). The reason for more frequent usage of non-commercial solutions is also an online application Google Maps (free version). Again, the highest rate of commercial online GIS application (with at least rare usage) has been observed for the group of GIS teachers, which is probably a result of lower prices for educational purposes. However, a reason for using commercial software and web applications in (GIS) education might also be more user-friendly designed interfaces (with no programming skills required) and customer support.

Very common commercial online GIS applications are ESRI's ArcGIS Online (large majority), followed by payable services of Google Maps. Other platforms are seldom used.

It is important to note that a large majority of CH experts use non-commercial desktop software and online applications more often than corresponding commercial solutions. There are several possible reasons for such a situation. Some reasons might involve a simple lack of the awareness of possible software offer, a lack of needs for specific tools (that are not available in non-commercial software packages), or limited financial and staff resources dedicated to the GIS. Another reason could be the fact that some commercial software does not support certain export or import file formats or have other usage limitations. Therefore, various initiatives and movements of open source communities emerged to support the development of open source GIS worldwide. Reasons for non-commercial usage in CH institutions were not discovered in detail and are beyond the scope of our analysis. However, currently the usage of non-commercial software is undoubtable. Therefore, special attention should be paid to non-commercial solutions of GIS education.

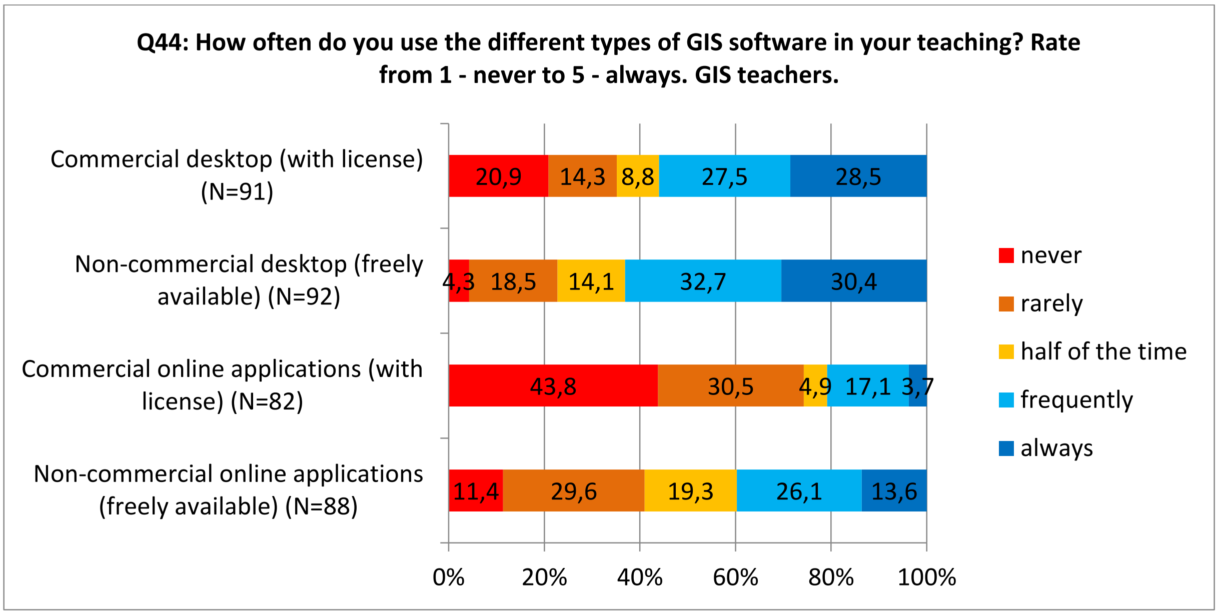


Figure 23: The GIS software usage by GIS teachers.

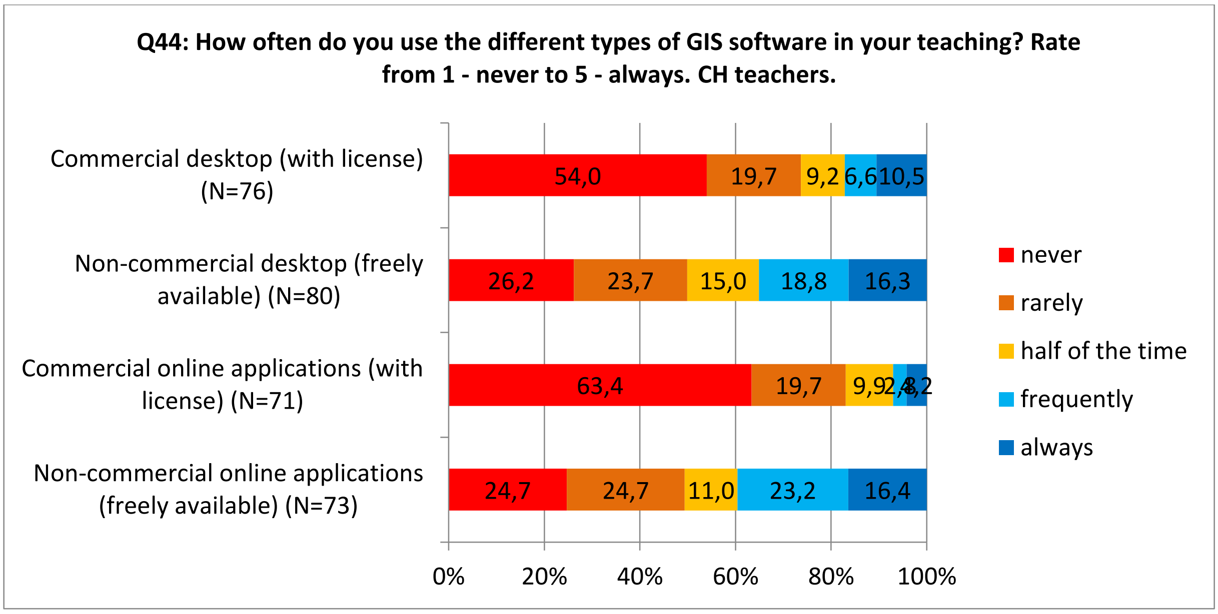


Figure 24: The GIS software usage by CH teachers.

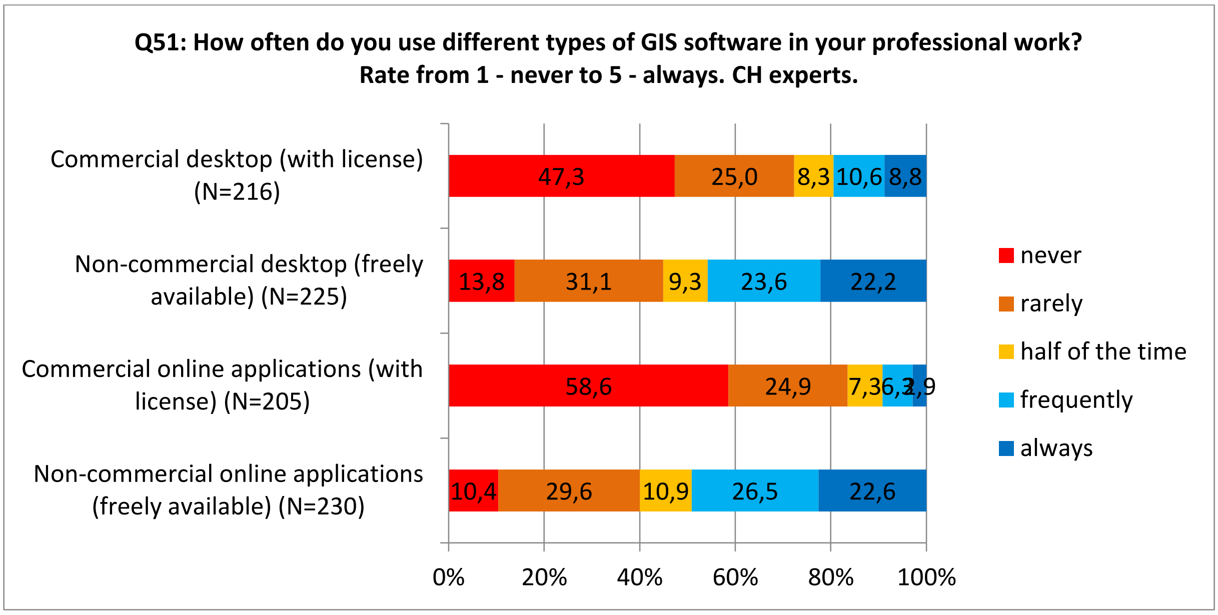


Figure 25: The GIS software usage by CH experts.

2.2.4 Usage of GIS for data management

Data management is one of the main pillars in every field, including GIS and cultural heritage. In this part, our analysis focuses on a question of what kind of data types and scale levels are involved in the respondents' work and what tasks do respondents perform.

Our study reveals that the majority of GIS and CH teachers' tasks are done at regional level (encompassing approximately a few km^2 areas), followed by local and nationwide levels, whereas CH experts focus most of their work on local and regional level (both represented by app. 2/3 of cases). Continental and global level is more significant for a group of GIS teachers (Fig. 26).

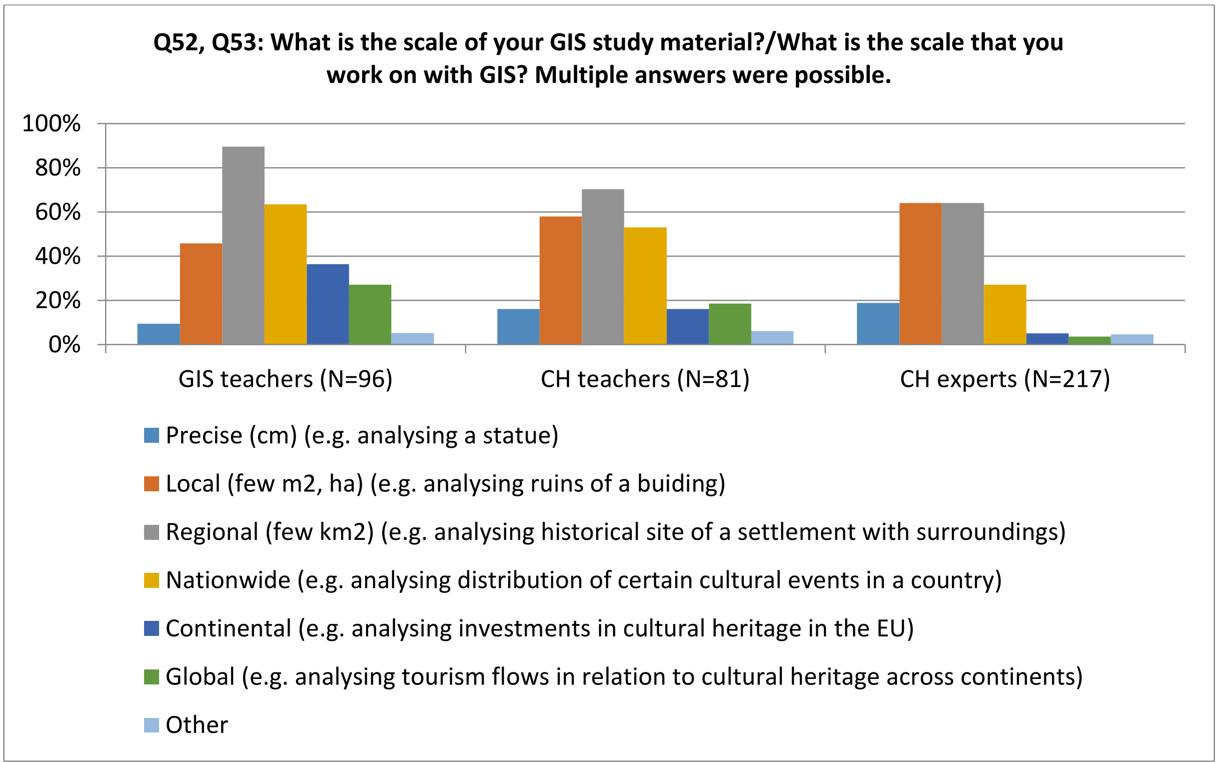


Figure 26: The scale of the GIS study and work material.

Respondents use different types of data. Vector data is the most frequently used data type in each target group. Compared to GIS teachers, the other two groups (CH teachers and experts) use vector data significantly more than other data types. Raster data (digital elevation model) is the second most frequent data type used by GIS teachers. Quite evenly distributed with little variance are the rest of data types in groups of CH teachers and CH experts (Fig. 27).

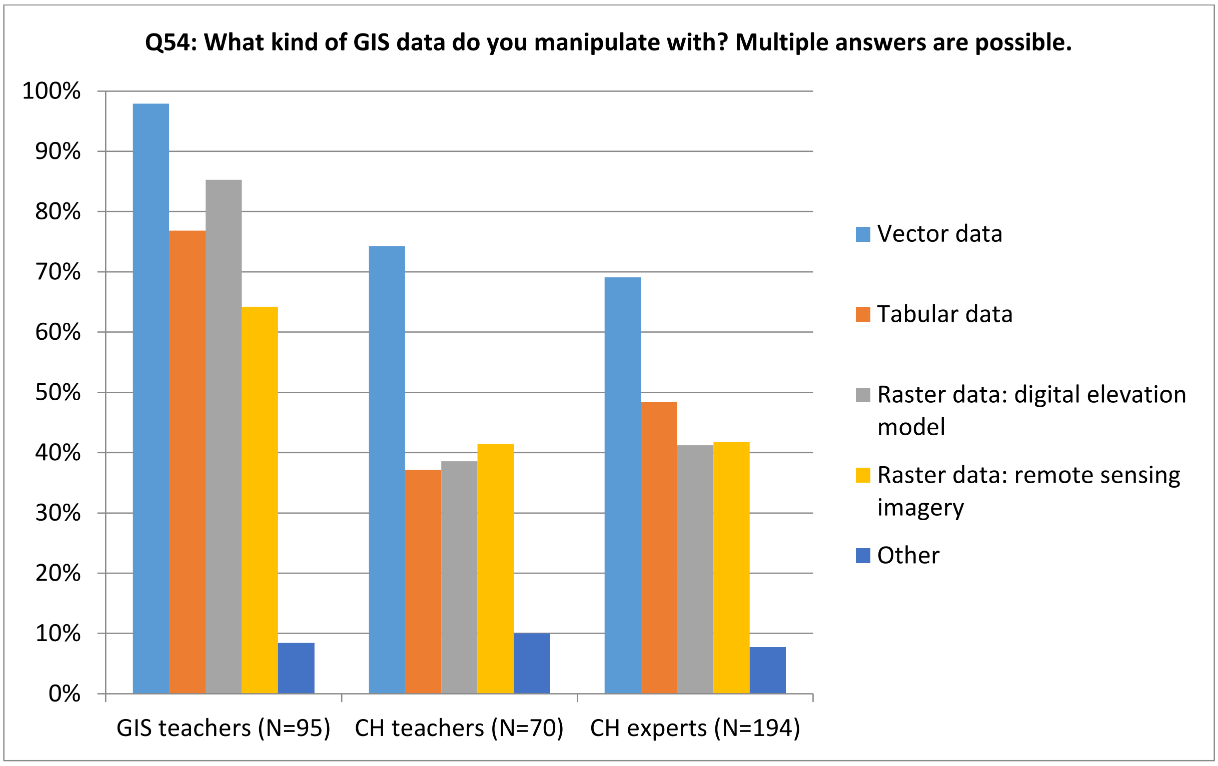


Figure 27: The type of GIS data used in teaching and practice.

An interesting relationship can be observed when comparing the type of GIS knowledge on data management involved in the education process and the needs of CH experts (see Figs. 28 and 29). The most frequent topics in GIS and CH education process are querying, relating data (tables) and conversions, however, most of CH experts identified knowledge on metadata management as the one that should be improved (followed by querying, relating data; access management; and conversions), although they (CH experts) most frequently work with querying, relating data (see Fig. 28). The answers of CH experts seem reasonable, because each dataset has to be accompanied with complete metadata information in order to guarantee transparency and repeatability of any actions. The responses under the category 'others' are very mixed and some are even related more to the tasks that are more related to other sections of GIS tasks (discussed in next subchapters).

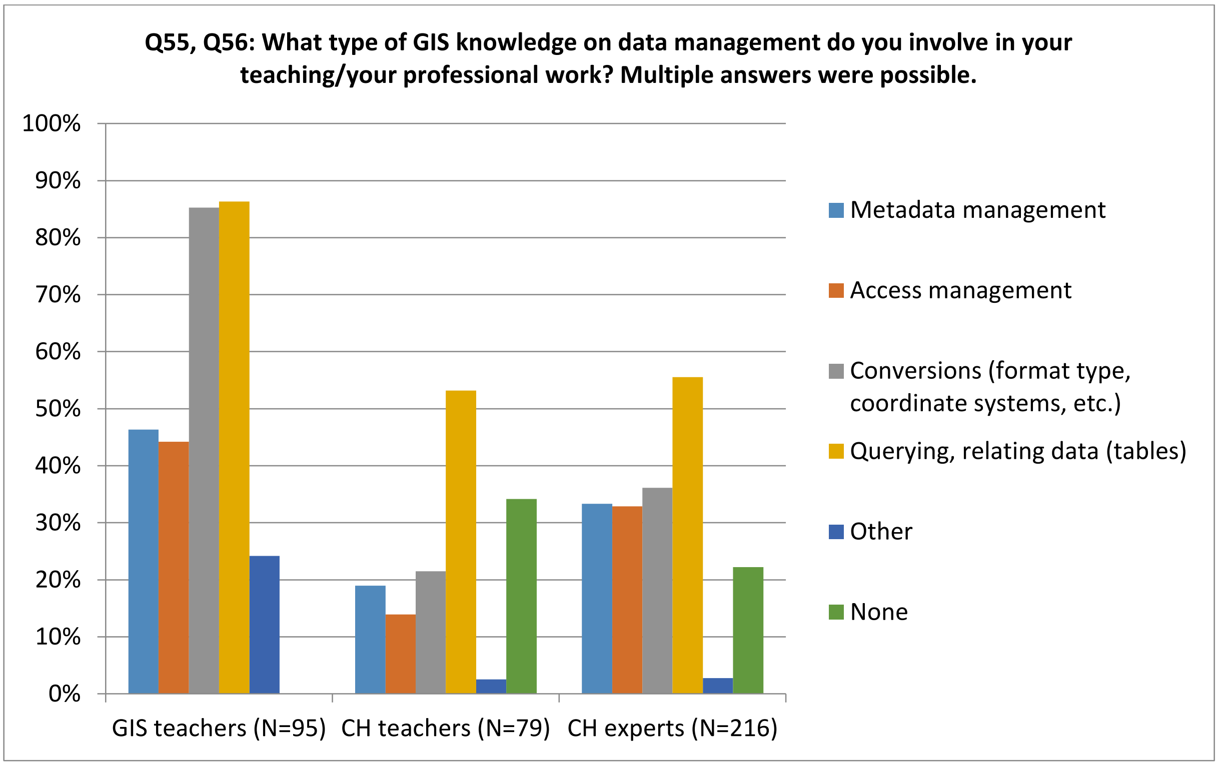


Figure 28: Frequency of teaching and practicing different types of knowledge on data management.

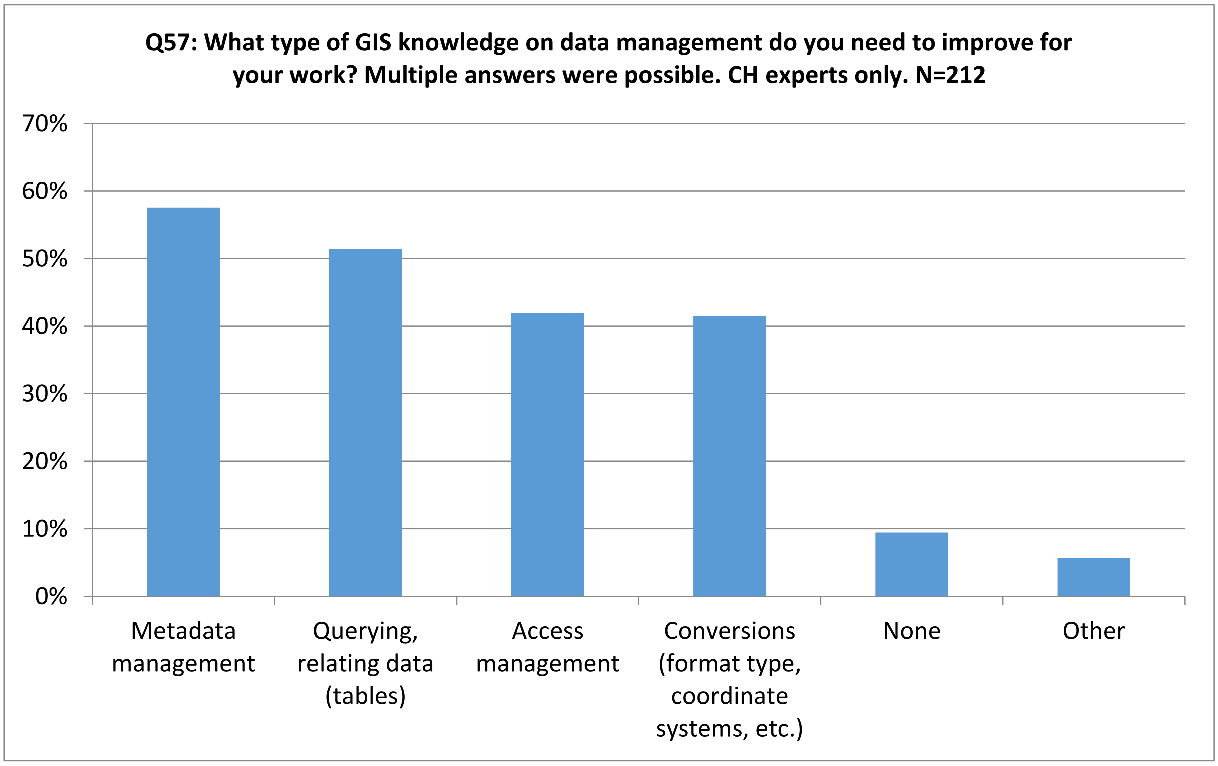


Figure 29: Frequency of different types of knowledge needs on data manipulation.

In order to compare the teaching content, the usage, and the needs (wishes) of GIS tasks on data management by CH experts more clearly, we have ranked the tasks and compared them by target groups (Table 7). According to the CH experts' current GIS task practice, the current education content seems sufficient. However, there are some differences between the CH experts' needs. The analysis showed that emphasis on access management and, especially, metadata management should be intensified.

Table 7: Comparison of teaching, practice and needs of GIS task on data management.

	Ranking according to the frequency of CH and GIS teachers' teaching (Q55)	Ranking according to the frequency of CH experts' work (Q56)	Ranking according to the frequency of experts' wish (Q57)	**Difference between teachers' teaching ranking and experts' work ranking (Q55-Q56); higher values present higher needs from experts**	**Difference between teachers' teaching ranking and experts' wish ranking (Q55-Q57); higher values present higher needs from experts**	Difference between experts' work ranking and experts' wish ranking (Q56-Q57); higher values present higher needs from experts
Access management	4	4	3	**0**	**1**	1
Conversions (format type, coordinate systems, etc.)	2	2	4	**0**	**-2**	-2
Metadata management	3	3	1	**0**	**2**	2
None	5	5	5	**0**	**0**	0
Other	6	6	6	**0**	**0**	0
Querying, relating data (tables)	1	1	2	**0**	**-1**	-1

2.2.5 Usage of GIS for data acquisition

Every GIS-based solution starts with the data acquisition, i.e., the collection of analogue or digital data from the field on a basis of inquiries, remote sensing, point sensors, field mapping, digitization of analogue sources (e.g., maps), etc. There are many different options on how to collect data. In our study, we tried to match the list of tasks that are involved in the education process and the list of tasks practiced and/or needed by CH experts.

The most popular ways of data acquisition for all three target groups are digitizing analogue data (scanning and georeferencing), data harvesting, and field mapping with GPS (or generally speaking – GNSS) devices. GIS teachers more often also use remote sensing techniques and geocoding, and CH teachers and experts more often also use topographic surveying (Fig. 27).

The results show that the frequency of types of knowledge on data acquisition are quite similar to the frequency of knowledge types that should be improved according to CH experts' opinion (see Table 8 and Fig. 31). According to CH experts, more emphasis should be dedicated to geotagging. There is less need for geocoding. However, currently topographic surveying is quite a common task done by CH experts; therefore, it should also be more involved in the education process.

The ranking reflects the fact that work in the field of cultural heritage frequently deals with analogue subjects (monuments, archives, ruins, artefacts, etc.), which need to be digitized and located in the coordinate systems. Surprisingly, data harvesting is ranked very high, which might be connected to the growing amount of digital data online and the spread of social networks.

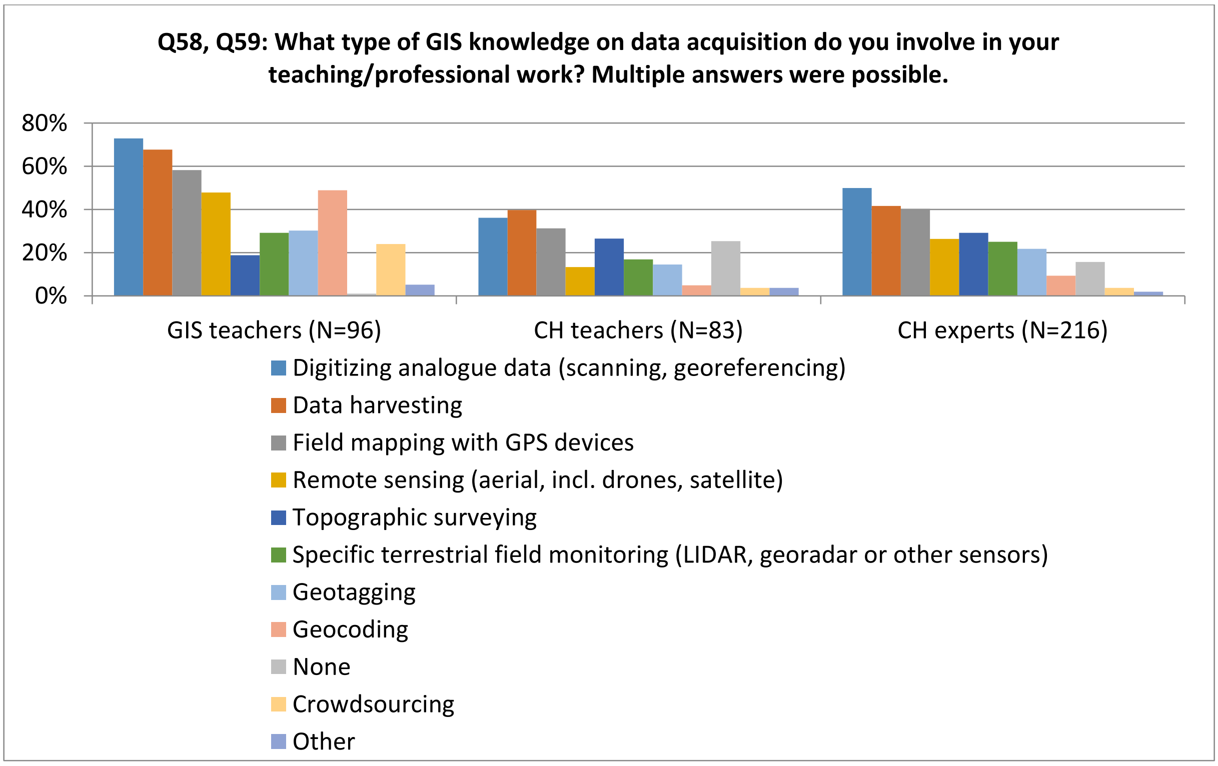
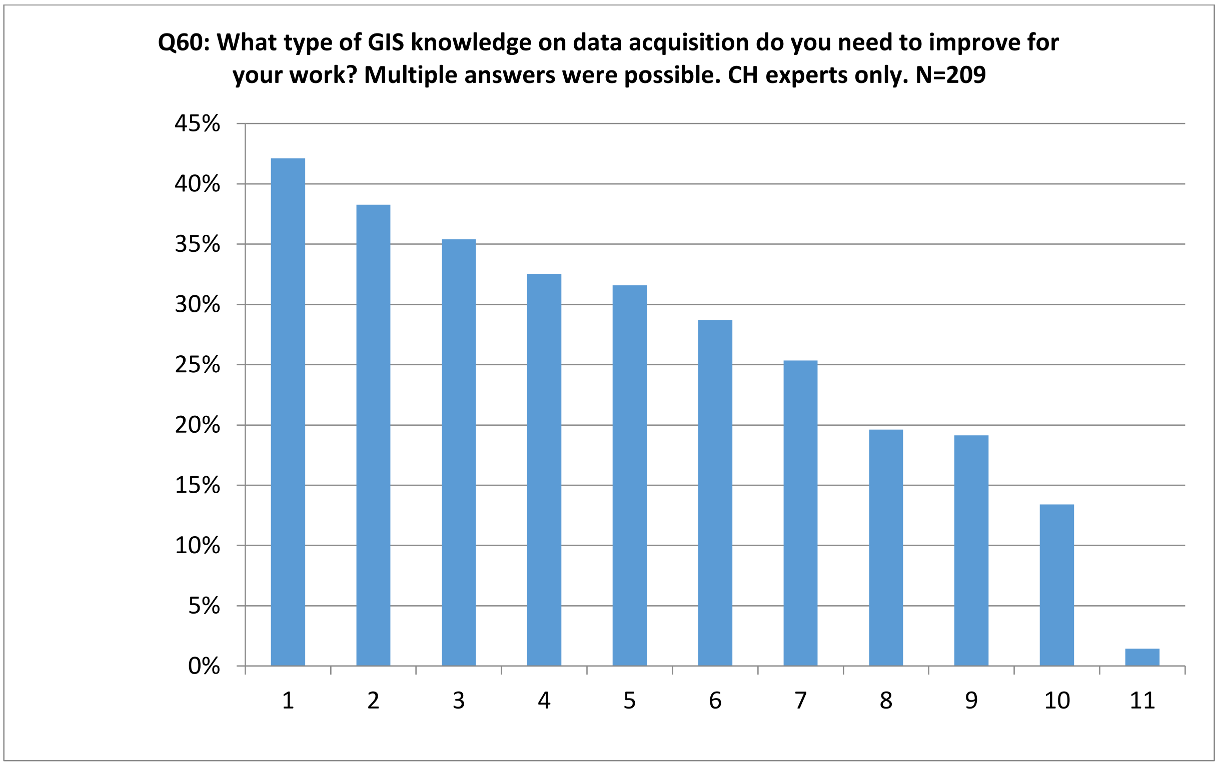


Figure 30: Frequency of teaching and practicing different types of knowledge on data acquisition.



1 Digitizing analogue data (scanning, georeferencing)
2 Data harvesting
3 Field mapping with GPS devices
4 Geotagging
5 Remote sensing (aerial, incl. drones, satellite)
6 Specific terrestrial field monitoring (LIDAR, georadar or other sensors)
7 Topographic surveying
8 Geocoding
9 Crowdsourcing
10 None
11 Other

Figure 31: Frequency of different types of knowledge needs on data acquisition.

Table 8: A ranking of types of knowledge on data acquisition.

	Ranking according to the frequency of CH and GIS teachers' teaching (Q58)	Ranking according to the frequency of CH experts' work (Q59)	Ranking according to the frequency of experts' wish (Q60)	**Difference between teachers' teaching ranking and experts' work ranking (58 - 59); higher values present higher needs from experts**	**Difference between teachers' teaching ranking and experts' wish ranking (58 - 60); higher values present higher needs from experts**	Difference between experts' work ranking and experts' wish ranking (59 - 60); higher values present higher needs from experts
Digitizing analogue data (scanning, georeferencing)	1	1	1	**0**	**0**	0
Data harvesting	2	2	2	**0**	**0**	0
Field mapping with GPS devices	3	3	3	**0**	**0**	0
Remote sensing (aerial, incl. drones, satellite)	4	5	5	**-1**	**-1**	0
Geocoding	5	9	8	**-4**	**-3**	1
Specific terrestrial field monitoring (LIDAR, georadar or other sensors)	6	6	6	**0**	**0**	0
Geotagging	7	7	4	**0**	**3**	3
Topographic surveying	8	4	7	**4**	**1**	-3
Crowdsourcing	9	10	9	**-1**	**0**	1
None	10	8	10	**2**	**0**	-2
Other	11	11	11	**0**	**0**	0

2.2.6 Usage of GIS for data analysis

Spatial data can be analysed in numerous ways. In our analysis we classified different tasks into ten groups trying to get an insight into what kind of knowledge is offered at the higher education institutions and what kind of knowledge is needed according to the CH experts' practices and opinions (wishes for improvement).

Concerning GIS analysis, GIS teachers most often perform vector analysis (involving proximity, overlay, etc.), combination of raster and vector analysis, raster map algebra, and vector network analysis. CH teachers often perform photogrammetry, vector network analysis, and combination of vector and raster tasks (Fig. 32).

The study shows that the most underdeveloped tasks on the labour market are photogrammetry and 3D analysis (Figs. 32 and 33). Both tasks are in a lower half of the tasks taught in higher education (photogrammetry ranks at 6th position and 3D analysis ranks at 8th position; see Table 9). The reasons for such needs might probably be very frequent GIS tasks in archaeology (analysing excavations and ruins) and detailed digital analysis of artefacts (sculptures, objects). Topology check is also a task that should be more involved in the education process. Statistics and advanced analytical processes (e.g. machine learning) seem to be less interesting for the field of CH. Vector network analysis is surprisingly highly ranked.

As expected, the majority (more than 3/4) of respondents do not include programming in their GIS tasks (Fig. 34). When programming is involved by GIS, it is mostly used for batch processing (automatization of tasks), followed by web applications building and production of custom geoinformation tools. Other types of usage are very rare. As expected, CH teachers merely do not cope with programming. Interestingly, CH experts are the group that most often use programming for web applications and production of geoinformation tools, relatively speaking even more than GIS teachers do.

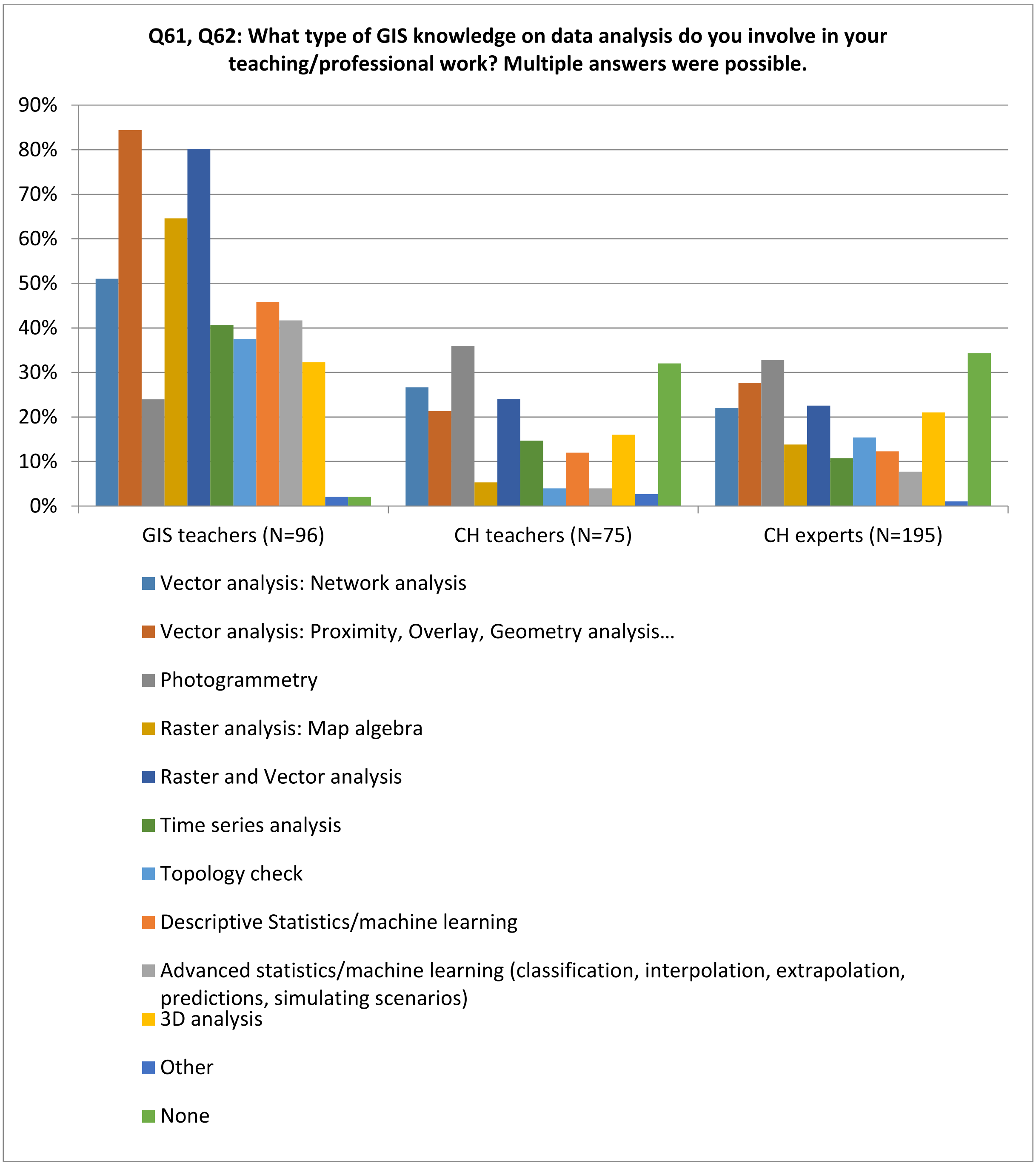
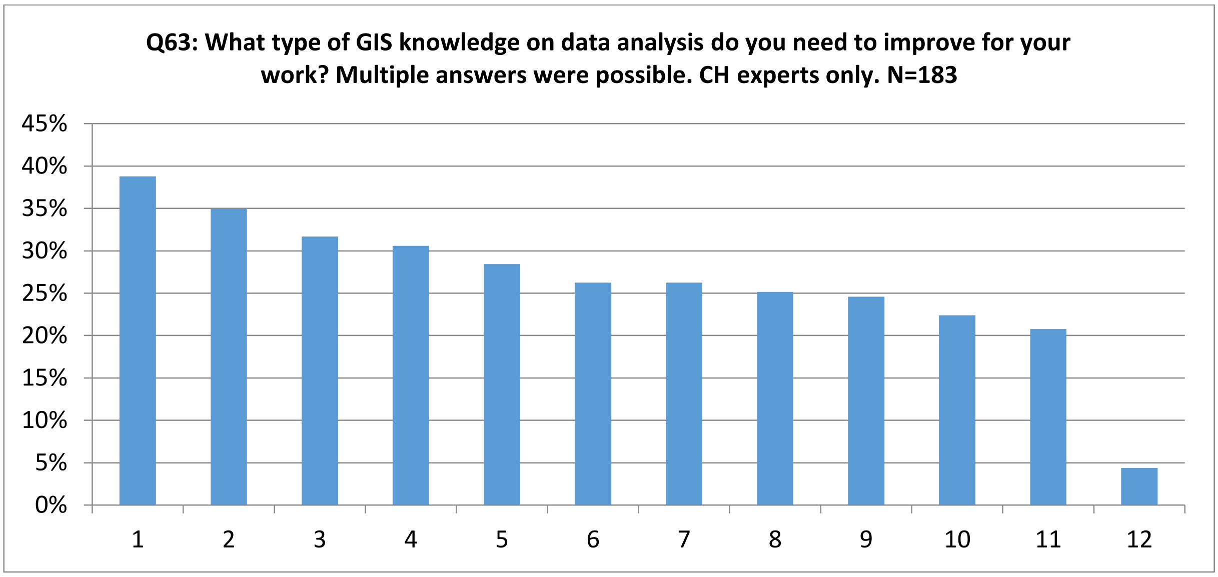


Figure 32: Frequency of teaching and practicing different types of knowledge on data analysis.



1	Photogrammetry
2	3D analysis
3	Vector analysis: Network analysis
4	Raster and Vector analysis
5	Vector analysis: Proximity, Overlay, Geometry analysis…
6	Raster analysis: Map algebra
7	Topology check
8	Time series analysis
9	Descriptive Statistics/machine learning
10	Advanced statistics/machine learning (classification, interpolation, extrapolation, predictions, simulating scenarios)
11	None
12	Other

Figure 33: Frequency of different types of knowledge needs on data analysis.

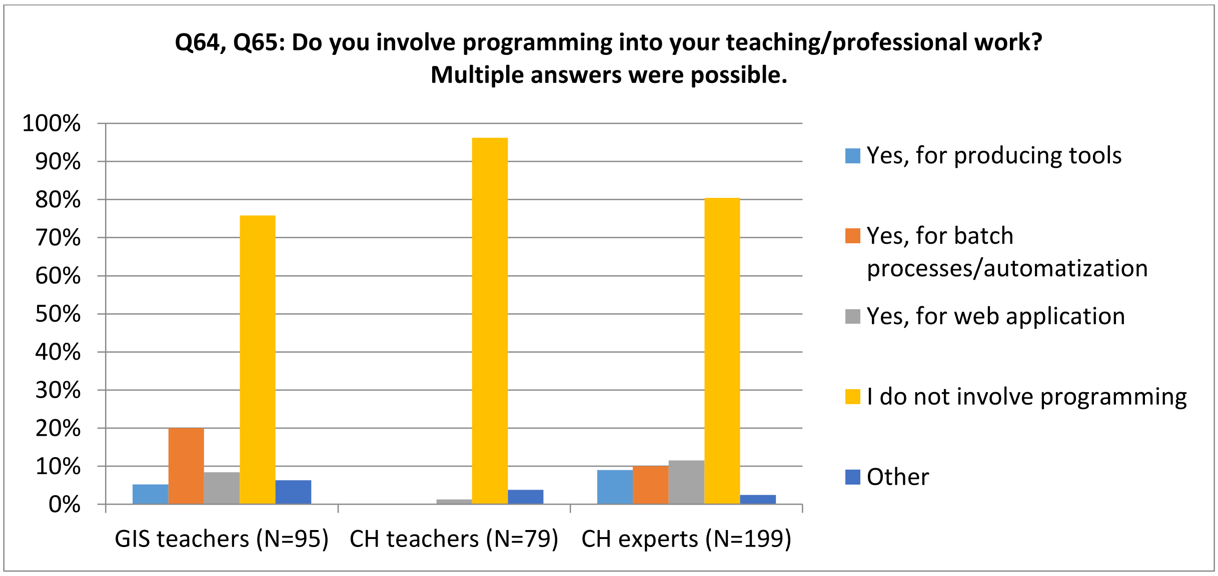


Figure 34: Programming involvement.

Table 9: A ranking of types of knowledge on data analysis.

	Ranking according to the frequency of CH and GIS teachers' teaching (Q61)	Ranking according to the frequency of CH experts' work (Q62)	Ranking according to the frequency of experts' wish (Q63)	**Difference between teachers' teaching ranking and experts' work ranking (61 - 62); higher values present higher needs from experts**	**Difference between teachers' teaching ranking and experts' wish ranking (61 - 63); higher values present higher needs from experts**	Difference between experts' work ranking and experts' wish ranking (62 - 63); higher values present higher needs from experts
3D analysis	8	6	2	**2**	**6**	4
Advanced statistics/machine learning (classification, interpolation, extrapolation, predictions, simulating scenarios)	8	11	10	**-3**	**-2**	1
Descriptive Statistics/machine learning	5	9	9	**-4**	**-4**	0
None	11	1	11	**10**	**0**	-10
Other	12	12	12	**0**	**0**	0
Photogrammetry	6	2	1	**4**	**5**	1
Raster analysis: Map algebra	4	8	6	**-4**	**-2**	2
Raster and Vector analysis	2	4	4	**-2**	**-2**	0
Time series analysis	7	10	8	**-3**	**-1**	2
Topology check	10	7	6	**3**	**4**	1
Vector analysis: Network analysis	3	5	3	**-2**	**0**	2
Vector analysis: Proximity, Overlay, Geometry analysis…	1	3	5	**-2**	**-4**	-2

2.2.7 Usage of GIS for data visualization and presentation of results

The last step of geoinformation work is the presentation of the results. These can be published by analogue or digital media.

The study shows (Fig. 35) that, generally speaking, most results are obviously provided by digital maps (this is the task that is most widely used, with more than 80% in each target group), followed by printed maps and web applications. Therefore, knowledge on cartography is frequently involved and useful for presentations of results. In groups of CH teachers and CH experts, the knowledge on cartography for digital maps is the most frequent, followed by cartography of printed maps and web applications (both between). Little less important in these two groups is a presentation in the form of 3D models (the percentage is similar also if we take into account CH experts only), which is quite low according to the fact that photogrammetry and 3D analysis were frequently marked as needed (see previous subchapter).

However, according to the question on which knowledge needs to be improved, the knowledge on how to prepare 3D models was the second most frequently selected by CH experts. The most frequent improvement of knowledge was the one connected to the web applications. Both tasks are followed (quite closely) by cartography for digital maps. Less than 30% of respondents marked cartography for printed maps as something that should be improved in their work. However, according to the current practice of GIS tasks by CH experts, the knowledge on cartography of printed maps is probably still needed (Fig. 36 and Table 10).

The results show that currently cartography (for digital or printed media) is the most common task, however, the expansion of online platforms, online tools, smartphones and tablet computers with more or less constant internet connection are the reasons that CH experts are aware of future development that is mostly focused on web applications. The results clearly show that the presentation and visualization of results is highly connected to the digital media, especially websites, which might be an even more useful way of communication due to current solutions to COVID-19 restrictions (e.g. virtual exhibitions, presentations, events).

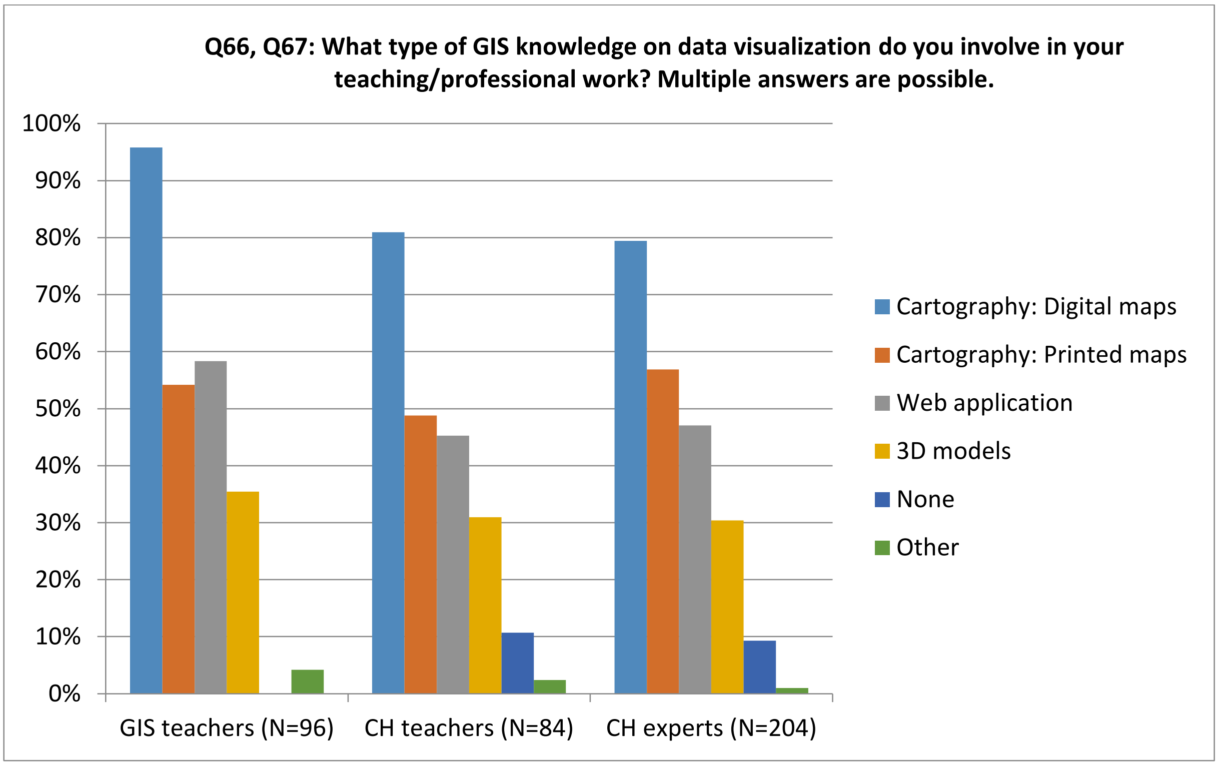


Figure 35: Frequency of teaching and practicing different types of knowledge on data visualization.

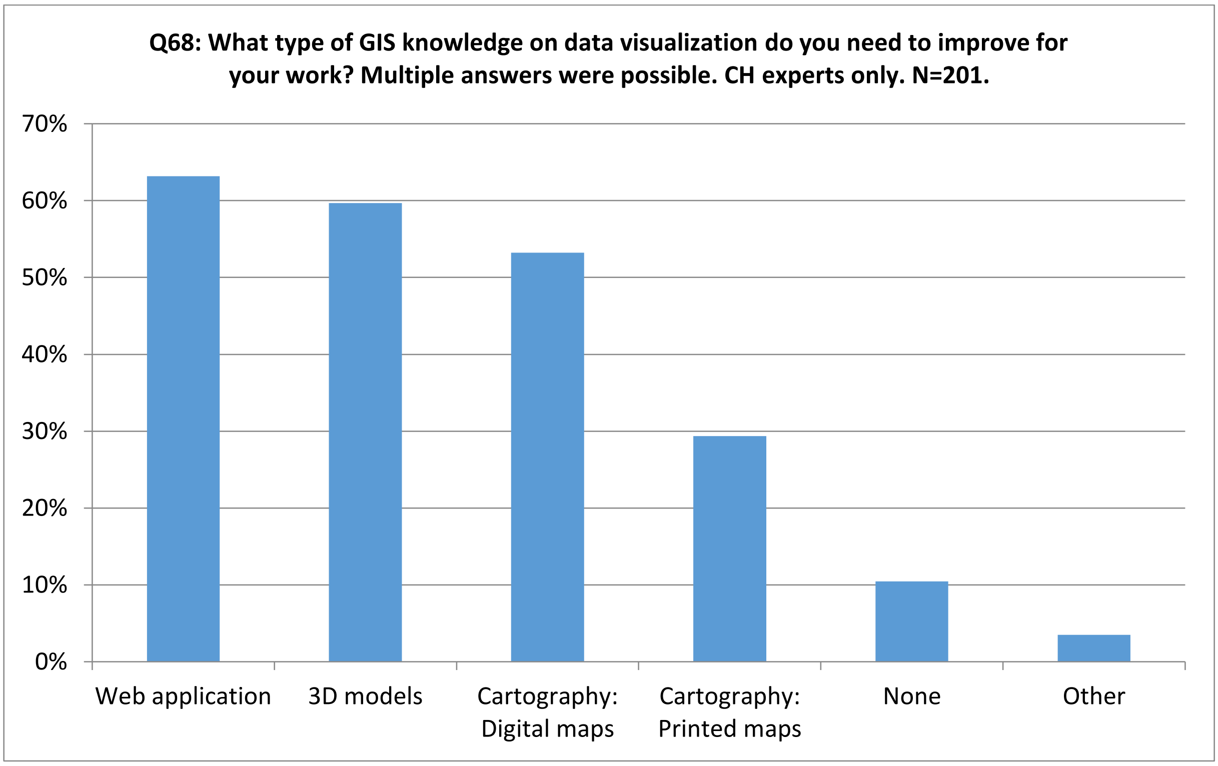


Figure 36: Frequency of different types of knowledge needs on data visualization.

Table 10: A ranking of types of knowledge on data visualization.

	Ranking according to the frequency of CH and GIS teachers' teaching (Q66)	Ranking according to the frequency of CH experts' work (Q67)	Ranking according to the frequency of experts' wish (Q68)	Difference between teachers' teaching ranking and experts' work ranking (66 - 67); higher values present higher needs from experts	Difference between teachers' teaching ranking and experts' wish ranking (66 - 68); higher values present higher needs from experts	Difference between experts' work ranking and experts' wish ranking (67 - 68); higher values present higher needs from experts
3D models	4	4	2	**0**	**2**	2
Cartography: Digital maps	1	1	3	**0**	**-2**	-2
Cartography: Printed maps	3	2	4	**1**	**-1**	-2
None	5	5	5	**0**	**0**	0
Other	6	6	6	**0**	**0**	0
Web application	2	3	1	**-1**	**1**	2

2.3 SUMMARY OF KEY FINDINGS

The objective of this study is to assess the levels, needs and potentials of integration of geographic information systems (GIS) in cultural heritage (CH) in courses of higher education and activities of the professional labour market. To this end, an online survey among three target groups (GIS teachers, CH teachers, and CH experts) was implemented between December 2020 and January 2021 in six partner countries (France, Greece, Italy, Serbia, Slovenia, and Spain). The sample of 649 respondents presents a diverse set of actors encompassing various backgrounds and skills (in GIS and CH), and types and sizes of institutions, which pertain to a wide generalizability of the results. The respondents predominantly hold a tertiary education and are middle-aged. However, there are some significant differences in gender balance. GIS teachers are more male dominated, while both CH groups are more inclined towards females. Due to execution of the survey in selected countries, the results are more representative for southern Europe. Future studies should, thus, pay more attention also to other European regions. The results of the survey offer an insight into two tasks of the first intellectual output (IO1) of the MINERVA project encompassing 1) competences of higher education teachers in the fields of GIS for CH and 2) labour market vs higher education matchmaking.

2.3.1 Competences of higher education teachers

CH teachers are highly familiar with the topics of GIS and highly value the importance of teaching GIS for cultural heritage. However, more than 60% of CH teachers never or rarely use GIS in teaching and more than half of them estimate the amount of time dedicated to teaching GIS as insufficient. Conversely, more than 60% of GIS teachers never or rarely use cultural heritage in their teaching. CH teachers are also in significant need of external GIS support to enrich their teaching. They outsource tasks from all stages of GIS (e.g. acquisition, analysis, visualization). Most often, they need support for mapping and other tasks such as digitization, georeferencing, data analysis, and 3D modelling. Therefore, there is a great potential for the integration of GIS subjects in the field of cultural heritage and vice versa. Both types of teachers could collaborate more often in developing theoretical and applicative solutions in the fields of GIS for cultural heritage.

GIS and CH teachers behave very similarly when it comes to main sources for teaching GIS. The most utilized category is ‘learning by doing’ where teachers put a lot of emphasis on practical work and illustrative-demonstrative methods. A typical example is to repeat an exercise explained in a classroom and do it in another study area and with other parameters. This type of education quite often includes self-learning via online material and/or software packages. Teachers sometimes also include students in applicative or research projects. Learning by doing is then followed by the categories of ‘textbooks’ and ‘tutorials’. The latter category most often includes tutorials of specific software packages such as ESRI ArcGIS and QGIS, short videos on YouTube and tutorials designed by teachers themselves. Online courses that are of particular interest for the MINERVA project represent a less important source for teaching GIS. Only about one third of GIS teachers and one fifth of CH teachers mentioned this category as a source for teaching GIS. In reality, e-lessons and online courses are dominated by other conventional methods of teaching and learning. These facts may indirectly indicate a need to develop such online tools to be more efficiently and widely used by teachers and learners.

GIS teachers use commercial and non-commercial software more frequently than CH teachers. Approximately 79% of GIS teachers use commercial software at least rarely compared to 46% of CH teachers and approximately 96% of GIS teachers use non-commercial software at least rarely compared to 74% of CH teachers. The reason for the lower use of commercial software could be the fact that most of them do not need to perform advanced geoinformation tasks and that most of the freely available software suffice. According to our study, most common commercial desktop GIS software are products of ESRI, followed by others (e.g., Mapinfo and Terrset). The vast majority of freely available software represents QGIS. When it comes to the online GIS applications, higher frequencies of non-usage have been observed for the commercial versions. Commercial online applications are at least rarely used by 56% of GIS teachers compared to 37% of CH teachers and non-commercial online applications are at least rarely used by 89% of GIS teachers compared to 75% of CH teachers. The reason for more frequent usage of non-commercial solutions is also an online application Google Maps (free version). Very common commercial online GIS applications are ESRI's ArcGIS Online (large majority), followed by payable services of Google Maps. Desktop computers are the most frequent hardware used by GIS and CH teachers, probably because powerful desktop computers are needed for geoinformation tasks.

Our study reveals that the majority of GIS and CH teachers' tasks are done at regional level, followed by local and nationwide levels. Vector data represents the most important source of data for all the teachers. However, GIS teachers more often (generally more than 60%) also use other forms of data (raster and tabular). These are used by CH teachers to a lesser extent (approximately 40%). The most frequent topics in data management in GIS and CH education are querying, relating data (tables) and conversions. These tasks present the basic geoinformation activities that are frequently needed before the start of any other processes.

There are some differences in acquiring data between both types of teachers. GIS teachers' tasks involve digitizing analogue data (scanning and georeferencing), data harvesting, field mapping with GNSS devices, remote sensing, and geocoding, while CH teachers more commonly use data harvesting, digitizing analogue data, topographic surveying, and geocoding.

GIS teachers often perform vector analysis (involving proximity, overlay, etc.), combination of raster and vector analysis, raster map algebra, and vector network analysis. CH teachers often perform photogrammetry, vector network analysis, and combination of vector and raster tasks. GIS teachers also include some programming tasks in their analysis, but CH teachers practically do not. This is expected, since GIS teachers are more involved in spatial analysis and therefore some special solutions are needed (e.g., automation of processes for large numbers of files or production of additional tools not offered by existing software).

The final stage of GIS data processing includes data presentation. GIS and CH teachers have a similar relationship of tasks in this part. Mostly they practice cartography of digital maps, followed by cartography of printed maps or web application building. Approximately one third of teachers also involve 3D models.

2.3.2 Labour market vs higher education matchmaking

CH experts compared to CH teachers are a bit less familiar with the topics of GIS, but similarly highly value the importance of practicing GIS for cultural heritage. However, about 60% of CH experts never or rarely use GIS. They are in significant need of external GIS support to enrich their professional work and outsource tasks from all GIS stages (e.g., acquisition, analysis, visualization). Most often, they need support for mapping and other tasks such as digitization, georeferencing, data analysis, and 3D modelling. Those CH experts that use GIS in their professional work most often apply simple tasks of using the spatial databases (e.g., identification, querying, management). There is, thus, a great potential to intensify knowledge transfer of GIS from the academic environment to the professional sphere. The generations of CH students should enter the labour market better equipped with GIS tools and methodologies for cultural heritage.

A very important aspect of comparison between education and labour market is the relationship between commercial and non-commercial software solutions. Our study shows that the highest rate of commercial software can be assigned to a group of GIS teachers (with approximately 79% of at least rare usage) and much lower to a group of CH teachers (46%) and CH experts (53%). The usage of non-commercial software is higher for all groups (GIS teachers 96%, CH teachers 74%, and CH experts 86%). One of the reasons for the non-commercial software usage by CH experts might be high prices of commercial software (academic licences are usually cheaper). The other reason might be the fact that some highly specialized commercial tools are not needed and non-commercial tools cover all the needs. However, there is also an option that CH experts are not aware of all the usage possibilities. Detailed explanation cannot be properly presented, since the topic exceeds the frame of our study. However, higher education and labour market use similar software: the most common commercial software are ESRI's products, and the most common non-commercial software is QGIS. According to the online applications, non-commercial solutions are more often used both by teachers and experts. Among the applications Google Maps (free version) and ESRI's ArcGIS Online are the most frequent. Since smart phones with internet access, online presentations and meetings are getting popular (especially due to the current COVID-19 pandemic situation), web GIS should be encouraged at both levels – higher education and labour market.

In total, desktop computers are still the most frequent tool by all target groups. Probable reason is that powerful desktop computers are needed for geoinformation tasks. It has to be noted that drones in comparison to other specific GIS devices are also quite often used by CH experts. Therefore, this emerging field should get more attention in educational programs. In the last few years, unmanned aerial vehicles (UAV or drones) became popular for aerial imagery and production of orthophoto images, digital surface models, etc. Since cultural heritage involves analysis and preservation of archaeological sites, monuments, etc., the usage of drones can be very helpful. Such examples can also serve as learning examples for GIS teaching itself.

Data management is one of the main pillars of GIS. It was noted that CH experts are more commonly dealing with GIS work at local (an area of a few square meters or hectares) and regional level (an area of a few square kilometres) and also at nationwide and precise levels (approximately 20%). On the other hand, teachers are dealing with their tasks most often at regional, nationwide, and local levels. Therefore, more focus on precise and local level should be dedicated in the future education processes (e.g., by using a specific archaeological site as a learning example). CH experts mostly work with vector data, followed by tabular and various sorts of raster data. The structure is similar to CH teachers.

Most CH experts identified knowledge on metadata management as the one that should be improved (followed by querying, relating data; access management; and conversions), although CH experts most frequently work with querying, relating data. The most frequent topics in GIS and CH education process are querying, relating data (tables) and conversions. According to the CH experts' current GIS tasks, current education content seems sufficient. However, the analysis showed that emphasis on access management and, especially, metadata management should be intensified. These kinds of tasks are especially important in different heritage registers, repositories and similar institutions with lots of material and data (e.g., museums).

Spatial data can be collected in a variety of different ways. CH experts most often acquire data by digitizing analogue data (scanning and georeferencing), data harvesting, and field mapping with GNSS devices. Digitizing of analogue data is for example very useful when working with archival material (e.g. historical maps) and field mapping is for example a common practice at excavation sites, where precise original locations of a site must be documented. According to current GIS practices of CH experts, some more attention to topographic surveying should be dedicated in higher education.

Additionally, CH experts wish to improve their skills in geotagging, which connects different material (e.g. photos) with spatial location.

Concerning GIS analysis, the study shows that CH experts mostly deal with photogrammetry and various kinds of vector analysis. 3D analysis and a combination of raster and vector analysis are also present. It was noted that photogrammetry is not very common learning material on the list of GIS teachers. Therefore, it is not surprising that photogrammetry (followed by 3D analysis) is the task that CH experts rate as the most important to improve. However, it seems that CH teachers are aware of this situation, since they involve photogrammetry relatively often in their educational process. Besides photogrammetry, also 3D analysis and topology checks should be more involved in education processes. As already mentioned, photogrammetry and 3D analysis are especially helpful for tasks such as detailed research and preservation of cultural heritage sites, statutes, etc.

Presentation of results of GIS work in the field of CH is often tied to cartographical images. CH experts most often use digital maps, followed by printed maps, web applications, and 3D models. The relationship among the types of presentation is similar to the frequency of their occurrence in the education process. However, CH experts estimate that knowledge on how to present 3D models and web applications should be improved. The study shows that the presentation of results is obviously often connected to the digital media. This is not surprising, since nowadays, there is a strong wish for detailed virtual reality implementation in various fields, including CH.

3 GEOTECHNOLOGIES FOR CULTURAL HERITAGE COURSE FEATURES AND CREDENTIAL SYSTEM

3.1 GENERAL FEATURES OF A COURSE IN GEOTECHNOLOGIES FOR CULTURAL HERITAGE

In order to guide teachers in planning and defining syllabi for teaching Geotechnologies for Cultural Heritage (CH), an overview of the main components of a course in Geotechnologies for CH is provided here. The course is usually structured around one overarching introductory module on GIS Theory and GIS/CH interface and followed by four (4) overarching modules, namely: (1) data acquisition; (2) data management; (3) data analysis; and (4) data visualization. Thus, it includes different types of contents such as remote sensing, spatial reference system, GIS for CH analysis and cartography. Table 11 reports a template for such a structure, without details on sub-modules, levels, duration, format (e.g., on-site, online, hybrid, inclusive of fieldwork), but it also gives some examples of the skills which are expected to be acquired by the students.

Table 11: General structure of a course in Geotechnologies for Cultural Heritage.

Overarching modules[4]	Examples of contents	Examples of expected skills to be acquired by students
0. Introduction	Introduction to the MOOC, its goals and expected outcomes Theory of GIS GIS/CH interface (example of GIS in CH)	Ability to understand GIS theory and the role of GIS in CH (with focus on specific aspects of relevant CH).
1. Data acquisition	Remote sensing Drone (UAV) Laser scanning GNSS (Global Navigation Satellite Systems) Georeferencing Raster/Vector data production Topology	Ability to retrieve, collect and store different types of geographic data at different scales / Basic use of main data acquisition methodology and tools / Capacity to assess the quality of data and metadata.
2. Data management	Spatial reference system Geodatabase	Capacity to understand basic GIS terminology / Ability to store, manage, integrate geospatial information / Capacity to assign correct CRS to data / Ability to ensure quality and integrity of data / Ability to manipulate with raster and vector data.
3. Data analysis	GIS for CH analysis GIS for landscape analysis	Ability to perform spatial analysis for CH and landscape with vector and raster data (e.g., raster algebra, DEM/DTM analysis, geometry, descriptive and advanced statistics, spatial statistics, photogrammetry, 3D analysis).
4. Data visualization	Cartography and mapping (scale and resolution) WebGIS Dashboards Apps	Ability to create effective printed and digital maps, graphs, charts, statistics, basic 3D visualization, web maps that can be easily understood / Ability to communicate results of spatial analysis carried out. / Capacity to understand the correct tool for data visualization.

[4] Each overarching module (with the exception of the introductory module) will include different sub-modules with respect to both content and level.

3.2 THE EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS) AND GEOTECHNOLOGIES COURSES FOR CULTURAL HERITAGE

As the MINERVA MOOC is designed as an output of a transnational partnerships among 6 higher education institutions, it is framed within the European Credit Transfer and Accumulation System (ECTS), in order to guarantee further mobility, exchange and inclusiveness and accessibility. In fact, ECTS – a central tool of the Bologna Process[5] – has been adopted by most of the countries in the European Higher Education Area as the national credit system (and is increasingly used elsewhere), and designed to facilitate mobility by higher education students between countries through the recognition of academic qualifications and study periods abroad. In summary, it is a tool of the European Higher Education Area[6] for making studies and courses more transparent and portable.

While this system is mostly known to enhance the flexibility of study programmes for students, it is also a strong framework for the planning, delivery and evaluation of higher education programmes. In fact, not only it enhances the comprehension of the learning outcomes and workload of programmes of study, it also allows for blending different learning styles, such as university and work-based learning, within the same programme of study or within lifelong education training programmes. Therefore, it also provides a framework for teachers in European as well as in extra-European countries also to convert it into their national credentials[7].

Table 12: General structure with ECTS credits of a one-year Master's course in Geotechnologies for Cultural Heritage, with a minimum of 60 ECTS.

Overarching modules	Contents	ECTS	H teaching	H self-study
0. Introduction	Introduction to the MOOC, its goals and expected outcomes Theory of GIS GIS/CH interface (example of GIS in CH)	N/A	8	8
1. Data acquisition	Remote sensing Drone (UAV) Laser scanning GNSS (Global Navigation Satellite Systems) Georeferencing Raster/Vector Data Production Topology	15	105	270
2. Data management	Spatial reference system Geodatabase	15	105	270
3. Data analysis	GIS for CH analysis GIS for landscape analysis	15	105	270
4. Data visualization	Cartography and Mapping (scale and resolution) WebGIS Dashboards Apps	15	105	270
Total		**60**	**428**	**1088**

[5] https://ec.europa.eu/education/policies/higher-education/bologna-process-and-european-higher-education-area_en
[6] http://www.ehea.info/index.php
[7] See for instance International Credit Conversion Guide of the University of Arizona in the USA: https://transfercredit.arizona.edu/content/international-credit-conversion-guide-iccg.

As defined in, *inter alia*, the 2015 ECT Users' Guide, the ECTS credits represent the "volume of learning based on the defined learning outcomes and their associated workload" (EU, 2015, p. 10). Generally, 60 ECTS credits are the equivalent of a full academic year of study. Hence, the overall ECTS credits for "*a 'first cycle' (or bachelor's) degree consists of either 180 or 240 ECTS credits; while for 'second cycle' (or master's) degree equate to 90 or 120 ECTS credits (with a minimum of 60 ECTS). The use of the ECTS at the 'third cycle', or Ph.D. level, varies"* (Bologna Working Group, 2005, p. 9). Table 12 provides an example of how a one-year Master's programme can be structured on the basis of the minimum requirement for ECTS (60) with respect to hours of teaching and studying as well as to the skills to be obtained by the students.

These general features of a course in Geotechnologies for CH, as described above (see Section 3.1) can be of course aligned with the European Qualification Framework's levels (mostly level 6 and level 7, as in the case of the example in Table 12), depending on the level of the course with respect to the knowledge, skills, as well as responsibility and autonomy with respect to the learning outcomes.

The ECTS and the EQF provide great tools to ensure that the MINERVA MOOC can be used by Humanities Departments/Schools in Higher Education Institutions of the European Higher Education Area, even if there are differences at the national level. Table 13 below provides an overview of how CH teachers can include the MINERVA MOOC (or part of it) in their national contexts.

The table below highlights that MOOC-format could serve overall four main different functions: they could be part of degrees awarded by Higher Education Institutions, they could be stand-alone degree courses offered by Higher Education Institutions, they could also just be stand-alone training courses and self-learning opportunities. With particular reference to the latter cases, in positioning the MINERVA MOOC within the European Higher Education Area, it is also fundamental to address the option for the MOOC to issue "alternative credentials" (beside ECTS), given that MOOCs have evolved from open and free educational opportunities into paid opportunities providing some type of "credentials" (e.g., certificates) (Kato *et al.*, 2020).

First, it is important to take into account that there are many different types of "alternative credentials" which are emerging in Europe and beyond, with respect to new education opportunities, including MOOCs. In order to address the variety of "alternative credentials" – defined here as those "that are not recognized as standalone formal educational qualifications by relevant national education authorities" (Kato *et al.*, 2020, p. 8) – the European Higher Education Area is addressing the issues of formalizing the recognition of micro-credentials; and ERASMUS+ initiatives are tackling the harmonization of the micro-credential approach with respect to the Bologna Process as well as the credibility (quality-assurance) of MOOCs (see e.g., MICROBOL; and EMC/European MOOC Consortium).

The next sections provide a more focused discussion on micro-credentials, and possible utilization of micro-credentials with respect to MOOCs within the context of the European Higher Education Area.

Table 13: Different approaches for the utilization of MINERVA's MOOC (or part of it) in universities courses and training programmes.

How to include MINERVA MOOC or part of it in CH courses or programmes	Part of MOOC	Other comments	Examples of countries
Within academia / universities / higher education institutions			
Within teachers' CH course (level 6 or level 7)	Any overarching module – any sub-modules.	For instance, the "Introduction" module can be used as a tool to raise awareness of opportunities in the GIS/CH interface.	E.g., France
As level 6 courses (within Bachelor's degree)	E.g., modules at "Beginner 1" level.	Option: students can register individually and take the tests/exams within the course OR tests/exams can be designed by CH teachers.	E.g., France (up to 24 hours of teaching and 3 ECTS)
As level 7 courses (within Master's degree)	E.g., modules at "Beginner 2" level.	Option: students can register individually and take the tests/exams within course OR tests/exams can be designed by CH teachers.	E.g., Italy
As a single Master programme (Level 7) (60-90 ECTS)	All overarching modules including all tests, assessments, and final exam: the entire MOOC.	Students can register individually and the school can recognise MOOC in overall course offering.	e.g., Greece, Italy, Serbia, Spain
Within "self-teaching" options	The entire MOOC or selected parts of the MOOC.	Students will have to register individually and have the programme recognised by the university.	e.g., Spain
Within PhD programme	The entire MOOC (Masters) or selected parts.	Students can register individually (or they can just be self-learners without certification).	e.g., Slovenia
As a postgraduate course or as summer school offered by the universities	Selected parts of the MOOC.	The duration and the amount of ECTS will define the type of course offered (e.g., expert course, specialist course). It is important to check with universities with respect to credit-recognition/certification.	e.g., Italy, Spain
As practical traineeship or internship at level 6 or level 7	The entire MOOC or selected parts.	Students should register individually.	e.g., Slovenia
As advanced credits towards another degree	Selected parts of the MOOC.	Students should register individually.	e.g., Italy
Lifelong learning in universities	Selected parts of the MOOC.	To be noted that this system can use the European Credit System for Vocational Education and Training (ECVET).	e.g., Greece (25 hours = ECVET)
Beyond academia: museums, cultural institutions, public agencies, etc.			
Professional training programmes for CH experts	Selected parts of the MOOC.	Students should register individually. Also, in this context, it could be important to explore the application of "micro-credentials".	e.g., Slovenia

3.3 MICRO-CREDENTIALS AND GEOTECHNOLOGIES COURSES FOR CULTURAL HERITAGE IN THE EUROPEAN HIGHER EDUCATION SYSTEMS

A micro-credential is a proof of the learning outcomes that a learner has acquired following a short, transparently-assessed learning experience, as could be the case of a MOOC. They are awarded upon the completion of short stand-alone courses (or modules) done on-site, online, or in a blended format. The short courses can be provided by higher and vocational education and training institutions, as well as by different types of private entities, as a quick response to labour market needs for specific skills.

Short-term courses and related credentials – including micro-credentials – have arisen because of the need for more agile and timely training all over the workplace. It is a relevant aspect of lifelong learning: workers often need to acquire very focused skills in a short time frame because current work pace and related reskilling times are not compatible with monolithic training formats, even in the case of lower levels of academic education. For many employees, the investment in a course that lasts even a full year and of which only a minor part concerns the compelling reasons to attend it, is simply not a feasible option.

Hence, micro-credentials could make education more inclusive, as education opportunities could be developed as more flexible with respect to time and economic investment (*of course, depending on the costs of the courses providing micro-credentials*) and thus more accessible to all types of learners. They can open education up to more people because they provide "quantifiable" certification of flexible, short-term nature in the learning environment, while also offering a bridge – through transparent recognition process – in the formal education system (i.e., academic degrees). In this context, they can be particularly helpful for people who want to get "portable" recognition for short learning experience, when they would like to, *inter alia*:

- Update their current knowledge, without reading for a full degree;
- Bridge a gap between degrees, or their initial formal education, and the emerging needs of the labour market;
- Overall upskill or reskill, also towards a career transition/change.

Despite the fact that "alternative credentials" (e.g., certificates, badges, digital badges, micro-certifications, open badges, and nano degrees, micro-certifications, and mini degrees; see e.g., Kato *et al.*, 2020; and Orr *et al.*, 2020) have been used for several years, micro-credentials are far from being well defined and regulated: the different actors involved - organisations, universities, businesses, institutions and different geopolitical aggregates – may have somewhat different ideas on how they should be articulated.

Concerning the definition of "micro-credential", it has also been noted that sometimes the term "micro-credential" has been used to define the certification of a short-term learning course (in a more appropriate way), but it has also been used to define both the short learning course and the certification (Orr *et al.*, 2020), as we can see in the case of "FutureLearn" where some courses are labelled as "micro-credentials"[8]. Thus, it is important to highlight the distinction between the learning activities *per se* (e.g., short learning courses and MOOCs) from their certification which can be done through "micro-credentials", as emphasized by Orr *at al.*, (2020). In fact, Orr *et al.* define "*Micro-credentials as certifications, i.e., as documents that recognise the learning activities that take place during the course and the learning outcomes resulting from these learning activities. The focus on certifications as distinct from simply learning activities could be regarded as closer to the everyday*

[8] See Microcredentials and Online Programs - FutureLearn

understanding of the concept of 'credentials'" (Orr *et al*., 2020, p. 38). This definition is the one applied by the MINERVA Team.

While there are many common features and characteristics across what is currently defined as "micro-credential", such as the fact that they are linked to short learning activities (i.e., different from a full degree course); they could be relevant to labour market's needs and requirements related to specific knowledge and skills; and that they could result in wider impact on society by fostering lifelong opportunities (Orr *et al*., 2020, p. 38). However, there has been a lack of overall standardization and harmonization of the application of micro-credentials, at regional and national scales within education (maybe with the exception of the formalization of micro-credentials in New Zealand[9]).

Taking into account new challenges posed on the entire education sector, including higher education, by the impact of the COVID-19 Pandemic and related responses, the European Union has underlined the pressing need for a formalized and standardized approach to micro-credentials within the European Higher Education Area. The EU is thus leading the process towards defining micro-credentials, as demonstrated *inter alia* by several key reports such as the Analytical Report "Towards a European micro-credentials approach: a study of practices and commonalities in offering micro-credentials in European higher education" (Orr *et al.*, 2020) and the most recent Report "A European approach to micro-credentials - Output of the Micro-credentials higher education consultation group: final report" (EC, 2020) issued in December 2020. Further discussion on the application/utilization of micro-credentials have also been announced in the European Skills Agenda For Sustainable Competitiveness, Social Fairness And Resilience (EC, 2020a), as one of its 12 flagship actions to support the quality, transparency and uptake of micro-credentials across the EU; as well as in September 2020 Communication on achieving the European Education Area by 2025 (EC, 2020b) to emphasize higher education's key role in supporting lifelong learning and reaching out to a more diverse group of learners, and in Digital Education Action Plan (2021-2027) (EC, 2020c) with respect to quality assurance, validation, and recognition of courses and learning opportunities. Further steps and actions are currently being conducted towards establishing a framework by 2025 for micro-credentials' wider use, recognition as well as portability (EC, 2020d, p. 6).

In fact, all the above-mentioned efforts have clearly emphasized the importance of a European approach, as also described in the above-mentioned report "A European approach to micro-credentials - Output of the Micro-credentials higher education consultation group: final report" (EC, 2020d). Here, we recall some of the pressing needs fostering such an approach:

- The European labour markets, **including both the Geotechnologies and Cultural Heritage labour markets**, are transforming rapidly, especially influenced by the impact of the COVID-19 Pandemic and ensuing regulations as well as by the ongoing digital revolution and ecological transitions, also within the framework of the 2030 Agenda and its Sustainable Development Goals (SDGs) (UN, 2015). Such rapid transformations call for more flexible and adaptable learning opportunities available for all stages of personal and professional life, as well as for all disciplines and sectors and interdisciplinary frameworks.
- Education opportunities have to become more inclusive, as committed in the 2030 Agenda (UN, 2015): there is a need to further inclusive opportunities for learners through more flexible and adaptable education and training opportunities, also towards enhancing lifelong learning dimension in higher education and towards fostering social, economic and pedagogical innovation.

[9] New Zealand's micro-credentials: Micro-credentials » NZQA

- As the ECTS process addresses mobility and portability of credits within the European Higher Education Area, there is the necessity to ensure that micro-credentials and related flexible and modular learning can be compared across Europe in order to ensure both quality standards of course certification, as well as the recognition of such certifications within both higher education and the labour market.

As highlighted in the previous paragraphs, micro-credentials offer recognition of more flexible and modular learning opportunities also adaptable to the MINERVA MOOC on Geotechnologies for Cultural Heritage which will include rapidly evolving features, given the rapidly changing field of geo-technologies, and which will be required to include a formal and wide recognition and certification across Europe.

Thus, we could address the challenge of the formal recognition of a MOOC at European level, by applying micro-credentials as certification, in line with current developments and strategy in the European Higher Education Area – a strategy which will also allow for the course to be easily developed and recognized in line with the European Qualifications Framework (EQF[10]). However, while such an approach can offer benefits in terms of stand-alone recognition and credential to the MOOC, it does not fully facilitate the integration of the MOOC within fully-fledged ECTS-based degree courses in the European Higher Education Area.

In this context, it is important to consider the current frameworks on the European approach to micro-credentials applied to MOOC courses, and how such frameworks intersect with the ECTS and the EQF also to further the interface between micro-credentials-based courses and ECTS-based full degree course (e.g., integration of MOOC into full degree courses).

3.4 MICRO-CREDENTIALS AND ECTS POSSIBILITIES FOR MASSIVE OPEN ONLINE COURSES (MOOCS)

Current debate in defining micro-credentials within EQF suggests that there should be considered two types of micro-credentials, one type for those micro-credentials issued by non-formal education providers, and the other type comprise “micro-credentials that are issued by formal education institutions and can be aligned with the EQF (through NQFs) and ECTS (or other credit systems)”, as there are already higher education transparency tools (e.g., EQF, ECTS) which can be applied in this context (EC, 2020d, p. 14 / Box 6). These latter characteristics guarantee that the course is developed in line with European Qualification Framework (EQF) and in particular with Level 6-7 equivalent to national qualification.

In this context, it is also important to reflect on how MOOCs have addressed the certification issues, while maintaining their main original characteristic: their openness. The term MOOC was defined in 2008 reference to a course “Connectivism and Connectivity Knowledge” (developed by S. Downes and G. Siemens): it is in the 2010s that MOOCs become established in education/training system (e.g., with the establishment of Udacity and Coursera in 2012; see e.g., MAUT, 2021).

Thereafter, the MOOC has been one of the vehicles to get lifelong learning, for its flexibility, openness and “initial no-cost”. This may also be related to the fact many employees and employers did not have the necessary budget for paying training courses, and thus MOOCs presented a great no-cost

[10] https://europa.eu/europass/en/european-qualifications-framework-eqf

learning/training opportunity. In fact, it is important to note that MOOCs started charging fees, to issue certification (i.e., to release alternative credentials such as certificates) (MAUT, 2021).

Despite, the increasing presence of fees related to MOOCs, there is a strong expansion of the MOOC planet which is a good indicator of MOOC as a successful tool for lifelong/flexible learning as shown in table 14. There is a great variability across MOOC with respect to, *inter alia*, mode of delivery, duration, timing, credit provision, providers, objectives, purpose of use, prerequisites, assessment, integration and stackability, as well as on the type of certification.

Table 14: Overview of the expansion of MOOCs on the basis of the reports by Class Central in 2019 and 2020[11].

	Students enrolled	Universities involved	Courses	Micro-credentials	Accredited courses
December 2019	120M	900	13.5k	820	50
December 2020	180M	950	16.3k	1180	67
Increase 2019-20	50%	6%	21%	44%	34%

In parallel to the debate on the standardization of micro-credentials across Europe, there are also current efforts on strengthening MOOC credibility as a learning approach in higher education. Here it is important to recall the activities of the European MOOC Consortium (EMC) – co-funded initiative by the ERASMUS+ Programme – which is also working towards the development of a Common Micro-credential Framework (CMF) to be used (on a voluntary basis) by the Consortium's member platforms (i.e., FutureLearn (UK), FUN (France), MiríadaX (Spain and Ibero-America), EduOpen (Italy), OpenupEd/ the European Association of Distance Teaching Universities (EADTU)), but also open to other new platform established in European countries (EMC, 2021).

In April 2019, the EMC launched the ***Common Micro-credential Framework (CMF)*** which, in order to ensure high quality standards across the courses issuing micro-credentials (referred to as "micro-credential courses"), requires that "micro-credential courses are capable of earning academic credits" – a *sine qua non* requirement which obliges courses to be developed within the national qualification framework and, also, in accordance to European Qualification Framework (EQF) (EMC, 2019). In this context, the CMF specifies that a course must exhibit the following characteristics:

- "Have a total study time of no less than 100 hours and no more than 150 hours (5/6 ECTS) including revision for, and completion of, the Summative Assessment.
- Be levelled at Level 6 or Level 7 in the European Qualification Framework or the equivalent levels in the university's national qualification framework.
- Provide a summative assessment that enables the award of academic credit, either directly following successful completion of a micro-credential or via recognition of prior learning upon enrolment as a student on the university's course of study.
- Operate a reliable method of ID verification at the point of assessment that complies with the university's policies and/or is widely adopted across the platforms authorised to use the CMF.
- Provide a transcript that sets out the learning outcomes for a micro-credential, total study hours required, EQF level and number of credit points earned" (EMC, 2019, p. 2).

[11] See reports and data at Class Central Webpages retrieved from https://www.classcentral.com/report/mooc-stats-2019 and https://www.classcentral.com/report/mooc-stats-2020/ (accessed 31/05/2021).

However, such a framework is very much fine-tuned with the interface with the higher education system; but less so with the labour market. In this context, the EMC has also developed the project "EMC-Labour Market" (EMC-LM[12]) which examines the interlinkages between the education and training sectors (universities, platforms) and the world of work (e.g., companies and Public Employment Services), also by addressing issues such as co-development of MOOC, and skills-gaps.

In addressing micro-credentials within the context of the labour-market, it is important to consider how MOOCs are recognised by the labour market and perspective/current employers (see e.g., Rivas *et al.*, 2020), how rapidly labour market's needs/requirements are changing also vis-à-vis developments in both science/technologies and in education sectors.

This overall context suggests the importance for teachers to identify whether the users are more inclined to have MOOC recognised through ECTS and those who are more inclined towards the recognition of MOOC via micro-credentials.

3.5 HOW TO ADAPT THE ECTS AND THE MICRO-CREDENTIALS OPPORTUNITIES TO THE MINERVA MOOC IN GEOTECHNOLOGIES FOR CH IN DIFFERENT EU STATES

Given the ongoing developments in geotechnologies and the increasing needs for their application to CH sectors, it is important to develop a MOOC which is adaptable to both the ECTS and the micro-credentials framework by defining different types of modules and identifying different learners' pathways.

As mentioned in Section 3.4, a type of micro-credentials concerns those micro-credentials which are issued by formal education institutions and can be aligned with the EQF and ECTS frameworks. Hence, the MINERVA MOOC can be designed both as a module of a degree-programme or as a fully-fledged degree programme issuing ECTS as well as micro-credentials depending on the learners' programme within the MOOC.

Taking into account that there are not so many Master-level degrees for Geotechnologies for CH in Europe, the MOOC has been designed as a full Master's level degree composed by different modules which can be taken as stand-alone short courses depending on what the learner would like to further her or his knowledge at a given time.

First of all, for each module and sub-modules of the MOOC should have two levels (e.g., "Beginner 1" and "Beginner 2/Advanced"); hence, a learner can have different options and pathways, including:

- Take all the modules and acquire the maximum value of ECTS for Master-level course;
- Take all the submodules for Beginner 1 and acquire a certain amount of ECTS or micro-credentials;
- Take all the submodules for Beginner 2 and acquire a certain amount of ECTS or micro-credentials;
- Take just one module in Beginner 1 and Beginner 2 and acquire a certain amount of ECTS or micro-credentials.

Tables 15 and 16 report, respectively, the course sample cards with scenarios for the "Beginner 1" level (i.e., Level 6 / Bachelor's level) and for "Beginner 2" (i.e., Level 7 / Master's level).

[12] See information at https://emc.eadtu.eu/emc-lm

Table 15: 1st scenario: based on Italian Post-graduate course (equal to 1 micro-credential, as 1 micro-credentials is estimated as 100-149 of teaching hours).

Overarching modules	ECTS	H teaching	H self-study
0. Introduction	N/A	8	8
1. Data acquisition	5	30	95
2. Data management	5	30	95
3. Data analysis	8	48	152
4. Data visualization	2	12	38
Total	**30**	**120**	**380**

Table 16: 2nd scenario: based on Italian Master's level course (equal to about 4 micro-credentials, as 1 micro-credentials is estimated as 100-149 of teaching hours).

Overarching modules	ECTS	H teaching	H self-study
0. Introduction	N/A	8	8
1. Data acquisition	15	105	270
2. Data management	15	105	270
3. Data analysis	15	105	270
4. Data visualization	15	105	270
Total	**30**	**248**	**1088**

It is to be noted that the given the flexibility of the MOOC with respect of modules/sub-modules, as well as differences at the national level, the amount of hours and related credits provided in the Tables above are to be considered indicative; yet they can be useful for CH teachers in order to plan their programmes and syllabi accordingly.

4 ASSESSMENT TOOLS FOR STUDENTS' DIDACTIC PROGRESSES

4.1 ASSESSMENT TOOLS AND FRAMEWORKS FOR STUDENTS' DIDACTIC PROGRESSES DESCRIPTION AND MODEL, WITH A SPECIFIC FOCUS ON ONLINE AND DISTANCE-LEARNING DIDACTIC MATERIAL

This section describes the best European assessment tools for students' didactic progress description and model identified by MINERVA Team towards the development of the MOOC on Geotechnologies for CH. First of all, given that the MOOC is designed and offered by the MINERVA Higher Education partners, and can be offered by Higher Education Institutions in the European Higher Education Area, the overall assessment of students' progress will follow ongoing frameworks applied to evaluation process also related to certification-process (e.g., ECTS and micro-credentials), as discussed above in chapter 3.

Table 17: Dublin Descriptors[13] (source: ECA, 2021).

Level 6 / Bachelor's level	**Level 7 / Master's level**
(EHEA European Higher Education Area) Dublin Descriptors	**(EHEA European Higher Education Area) Dublin Descriptors**
Knowledge and understanding	
have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study	have demonstrated knowledge and understanding that is founded upon and extends and/or enhances that typically associated with the first cycle, and that provides a basis or opportunity for originality in developing and/or applying ideas, often within a research context
Applying knowledge and understanding	
can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study	can apply their knowledge and understanding, and problem-solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study
Making judgements	
have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issue	have the ability to integrate knowledge and handle complexity, and formulate judgments with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgments
Communication skills	
can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences	can communicate their conclusions, and the knowledge and rationale underpinning these, to specialist and non-specialist audiences clearly and unambiguously
Learning skills	
have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy	have the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous

[13] A bachelor's degree (level 6) refers to the qualification awarded after successful completion of the first cycle in the Qualifications Framework of the European Higher Education Area. The degree usually requires a minimum of 180 and a maximum of 240 ECTS. A Master's degree (level 7) is the second-level higher education award. It refers to the second cycle in the Qualifications Framework of the European Higher Education Area. The degree usually requires a minimum of 90 ECTS, of which at least 60 ECTS at Master's level (ECA, 2021).

Taking into account recent research work on assessing students' progress within online and distance learning settings (see e.g., Del Gobbo *et al.*, 2020), particular attention will be based towards defining clear Learning Outcomes for each module/level, also in alignment with the "Dublin Descriptors". In fact, the Dublin Descriptors enable the definition of the Bologna levels (or cycles) presented in 2003, and then adopted in 2005 as the Qualifications Framework of the European Higher Education Area, and hence allow for providing more generic statements on expected achievements and abilities associated with awards that represent the end of each Bologna cycle/level. (ECA, 2021). Each level descriptor comprises the following five components:

- Knowledge and understanding
- Applying knowledge and understanding
- Making judgements
- Communication
- Lifelong learning skills (ECA, 2021).

Table 17 above provides more details with respect to level 6 and level 7 which are the levels considered for the MINERVA MOOC (i.e., Bachelor's and Master's).

On the other hand, the Learning Outcomes provide more specific statements "of what the individual knows, understands and is able to do upon completion of a learning process" (EU, 2015, p. 10), according to subjects studied. Hence, in order to define assessment-processes, it is important to clearly define the Learning Outcome for each of the two levels of the MOOC, as well as for each of the four modules. Here are the Learning Outcomes identified by the MINERVA Team.

For the overarching modules[14] (Data Acquisition; Data Management; Data Analysis; and Data Visualization):

- The student who successfully completes "Overarching Module 1: Data Acquisition" (Beginner 1+2) of the MINERVA MOOC will have the ability to master the basic concepts related to Remote Sensing, Drone (UAV), Laser Scanning, GNSS (GPS) and Georeferencing. She/he will be able to demonstrate a solid knowledge of the main data acquisition methodologies and tools, and to conduct/perform acquisition, collection and storage of different types of geographic data.
- The student who successfully completes "Overarching Module 2: Data Management" (Beginner 1+2) of the MINERVA MOOC will have the ability to master the basic concepts of GIS Theory, Spatial reference system, and Geodatabase. She/he will be able to demonstrate a solid knowledge of methodologies relevant for the management and integration of geospatial information as well as to the assignment of correct CRS to data, and to ensure quality and integrity of data.
- The student who successfully completes "Overarching Module 3: Data Analysis" (Beginner 1+2) of the MINERVA MOOC will have the ability to master the basic concepts of Spatial Analysis, GIS for CH Analysis, and GIS for landscape analysis. She/he will be able to demonstrate a solid knowledge of methodologies related to spatial analysis, and to perform spatial analysis for CH and landscape and to elaborate simple scenarios or forecasting models.
- The student who successfully completes "Overarching Module 4: Data Visualization" (Beginner 1+2) of the MINERVA MOOC will have the ability to master the basic concepts of Cartography and Mapping (scale and resolution), and WebGIS. She/he will be able to demonstrate a solid knowledge of the methodology and tools related to data visualization, and to create effective

[14] To be noted: more detailed "Learning Outcomes" for each sub-module will be available at the beginning of each sub-module within the MOOC.

maps, graphs, charts and statistics as well as to communicate the results of spatial analysis effectively.

For each level (Beginner 1 and Beginner 2 of "Geotechnologies for CH"):

- The student who successfully completes "Beginner 1" level of the MINERVA MOOC will have the ability to master the basic concepts of complete spatial research workflow, including all basic steps: from acquisition, data management, analysis, till final visualization. She/he will be able to demonstrate a solid knowledge of planning and establishing a general framework for spatial research and application with GIS in the field of CH. She/he will be able to understand and perform basic methods of geotechnologies for CH, such as creating simple maps, analysis, data handling, etc. She/he will be able to conduct/perform independent basic spatial studies and tasks and will have the ability of searching for more specific solutions on self-developed case studies and collaborating with other GIS experts in the general field of geotechnologies.
- The student who successfully completes "Beginner 2" level of the MINERVA MOOC will have the ability to master the basic concepts of complete spatial research workflow, including all basic steps: from acquisition, data management, analysis, till final visualization. Additionally, she/he will be able to understand and perform some advanced techniques for a specific field of CH. She/he will be able to demonstrate a solid knowledge of planning and establishing an advanced/complex framework for spatial research and application with GIS in the field of CH. She/he will be able to perform advanced methods of geotechnologies for CH, such as creating complex maps, advanced analysis etc. She/he will be able to conduct/perform complex spatial studies and tasks and give support to other users/co-workers. He/she will be able to communicate with other GIS experts in several fields of geotechnologies.

On the basis of these Learning Outcomes, and the Dublin Descriptors, different types of assessments have been defined by taking into account the nature of the MOOC as an online course (and hence that the tests and final exams have also to be performed online). However, in order to ensure inclusiveness of this MOOC; the opportunity to sit for final exams within designated MINERVA centres/labs could also be developed (especially if the final exams may entail the use of a specific software/hardware which may not be available/affordable to all students and/or institutions).

The tests as well as the overall contents of the MOOC will take into account accessibility issues in order to be as inclusive as possible and to reach a broader audience. In this context, all video/audio material will include captions and/or transcripts, and all the visual material will include written descriptions – this will support learners with disabilities (see e.g., Iniesto *et al.*, 2016; see also information on MOODLE[15]) as well as learners with limited knowledge of English.

The next section provides more details on the types of assessments which will be included in the MOOC within the framework of the above-mentioned Learning Outcomes and Dublin Descriptors.

4.2 INNOVATIVE TOOLS TO MEASURE COMPETENCES AND SKILLS ACQUIRED BY STUDENTS

The MINERVA Team focused on the importance of creating different instances in which the teachers (or self-learner) can assess students' (or own) progress within the MOOC, also to allow for different pathways (e.g., by level and by module/content). Thus, taking into account the above-mentioned Dublin Descriptors and those assessments are "important part of the learning process in MOOCs"

[15] MOODLE/Accessibility and Tips to make your LMS content accessible | Moodle

(Ventista, 2018, p. 166), the MINERVA Team created this innovative process to provide both further learning opportunities and assessments of students' progress with respect to competence and skills acquired by students. The process entails:

- Entrance test to evaluate students' level and to suggest pathway within the MOOC;
- *In itinere* tests to monitor progress of learning;
- Final exams at completion of overarching modules and at completion of MOOC.

4.2.1 Evaluating students' level before the MOOC

Prior to assessing the students' level, it will be important to get to know the prospective students with respect to demographics, academic/professional background (including prior experience in geotechnologies and/or CH), specific learning needs/requirements, as well as main motivation(s) for taking the MOOC. Hence, a registration form has been designed towards understanding whether those who are interested in the MOOC are in line with the expectations of the MINERVA project (e.g., CH teachers, CH students and CH practitioners). The registration form will be launched well-before the MOOC in order to use the registration also as an "advertising tool" for the upcoming MOOC (as well as for the MINERVA Project's activities).

Table 18: Questions for registration form which will include link to data/privacy policy and further information on the MINERVA MOOC and MINERVA Team.

Questions	**Compulsory/Optional**	**If question is multiple choice, select from**
Name and Last name	C	
Email address	C	
Nationality	O	
Gender	O	M/F/Other/Prefer not to say
Age	O	
Prior experience in geotechnologies	C	Y / N If Y - please give info
Are you a teacher in CH in higher education institutions? Other prior experience in CH?	C C	Y / N If Y - please give info Y / N If Y - please give info
Motivation	O	Teaching / Interest / Work / Credits
Special Learning Needs	O	Y/ N If Y - please give info
Interest in degree/certification	O	Y/NO If Y - you will be invited to an entrance test to evaluate your level If N - you can access the MOOC (with the exception of tests/exams)

Upon registration on the MINERVA Website, the prospective student can decide whether to take the MOOC for free (namely without tests and without credentials/certifications), or to enrol formally in the MOOC (namely by paying fees, seating for tests/exams and earning credentials/certifications). In the latter case, the prospective student will have to take an entry test to have her/his level evaluated in order to receive suggestions concerning the most relevant/adequate pathway within the MOOC (e.g., overarching modules at the second level only).

For this type of test, a computer-based "Multiple Choice Quiz" has been considered as the best option, giving immediate response to the prospective student. Upon completion of the entrance test/quiz, the student receives advice on which module/levels are the most appropriate to her/his level as well as the related information concerning fees/enrolment and expected credentials. The feedback also provides information concerning software/hardware requirements as well as an overall idea of the (average) time to be invested by the students for each of the suggested pathways, given that the time appears to be a main issue in MOOC participation (see e.g., Haniya and Paquette, 2020). This response also communicates information on current credits-gaps/debts which may need to be fulfilled prior to taking the MOOC, or it could provide advanced credits (up to 30 ECTS awarded for the "Beginner 1" level) towards the fulfilment of the required 90 ECTS required to obtain the Master's degree.

After the entrance test, prospective students will also have the choice not proceed with further registration for the MOOC as degree/certificates (incl. exams and fees). This option will allow teachers to identify the overall level of their students, and then to plan the utilization of the component of the MOOC as they consider appropriate. Teachers may eventually decide to ask students to repeat the entrance test at completion of the programme. Fig. 37 below recaps the information on this process, for ease of reference towards deciding on how to proceed with the utilization of the MOOC.

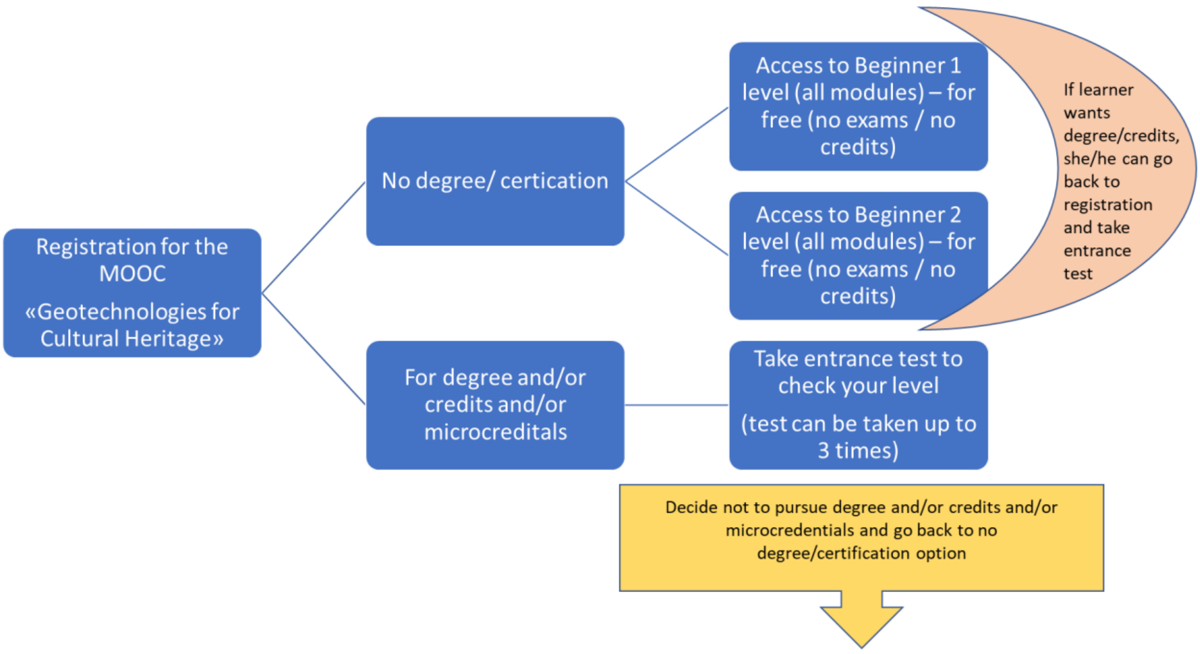


Figure 37: Route from registration towards deciding whether to take the MINERVA MOOC with or without exams/fees/certification.

It is also planned that the MINERVA Team could be contacted via a dedicated email for questions/clarifications concerning levels/modules prior to formal enrolment in the MOOC. Designated members of the MINERVA Team will be monitoring the dedicated inbox, and dispatch email accordingly to relevant Colleagues. The entrance test will have questions on all the main four main components/content of the MOOC and at different levels; and will provide feedback accordingly. Once joining the MOOC with the objective of obtaining certifications and/credits, the student will have to take some *in itinere* tests as well as exams. The process related to the graded exams and certification of credits are summarized in Fig. 38.

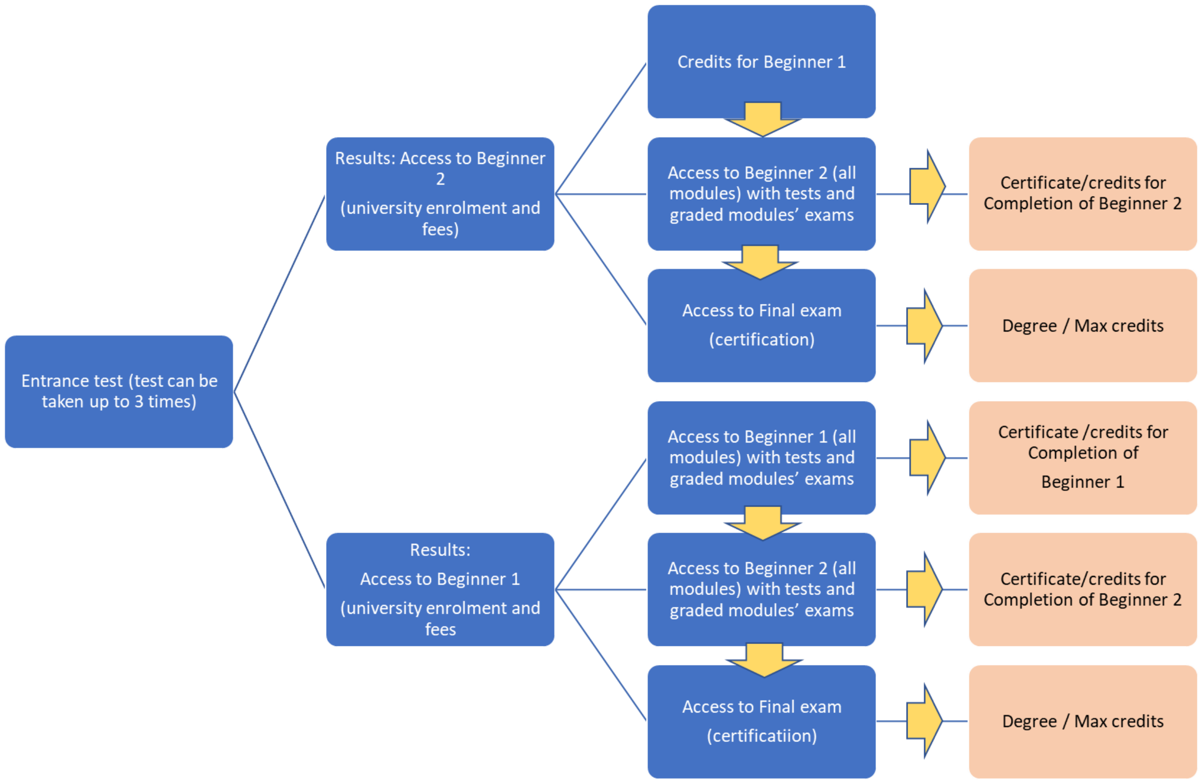


Figure 38: Overall structure of the MOOC and related assessments/exams and certifications.

4.2.2 Assessing students' progress throughout MOOC: *in itinere* tests

Throughout the MOOC there will be compulsory (yet ungraded) tests which can be considered as diagnostic tests and formative assessment within each level/module (the type and frequency of these tests is designed according to the content of the module). These tests are designed to provide further opportunities for learning as well as for motivating students. The formats which can be used for this type of test have been identified as follows:

- Multiple-choice quiz (this is preferred format);
- Answer open-ended questions on Forum/Blog (get comments by peers and then by faculty members and/or Members of the MINERVA Team);
- Perform case-study and describe them on Forum/Blog (get comments by peers and then by faculty members and/or Members of the MINERVA Team);
- Respond to questions posed by peers then commented by faculty member and/or Members of the MINERVA Team);
- Contribute to the Forum/Blog with comments/questions on lectures/videos.

These types of assessments can be further developed also through Higher Education tools provided by Moodle[16] or other services.

Furthermore, at the end of each level/module (e.g., upon completion of "Data Management-Beginner 1" and "Data Visualization-Beginner 2"), there will be a summative assessment which is associated with grading and certification-process (see e.g., Ventista, 2018). Each of these tests can be re-taken by the learner, if the learner is not satisfied with the grade (there will be at least two versions of the test

[16] Higher Education | Moodle

available at each MOOC session and they will be changed at every formal MOOC session). The summative assessment can be in the shape of developing a mini case study applying the relevant skills and know-how; this will be evaluated by a relevant MINERVA Tutor. Peer-reviews/assessment will not be applied here, given difficulties identified for other MOOCs (see e.g., Ventista, 2018).

Sample tests/exams with relevant template score-cards will also be made available for teachers (identified upon registration) so they can also customize their own tests/exams according to their needs related to subject matter.

4.2.3 Assessing students' progress throughout MOOC: *final exam*

A final exam for the entire MOOC will also be available, if the student has completed the entire MOOC, as this will be considered a "course" at level 7 of the Dublin Descriptors (see Table 17 above). The final exam will also be open to those who have been admitted directly to "Beginner 2" and have been granted advanced credits through the entrance test. In brief, a total of 90 ECTS is required to access the final exam towards being awarded a Master's degree (Level 7). Table 19 below provides an overview of the distribution of the ECTS by overarching modules and levels.

The final exam entails an open-ended project which will be evaluated by one or more faculty-members of the MINERVA Team. The project could be in the shape of a case study applying all the main skills acquired and forming a complete solution for specific/chosen spatial problem/issue related to CH; this will also allow for building a repository of MINERVA MOOC case studies which will be fed into the MOOC, upon appropriate review and finalization by the MINERVA Team. Each teacher could also add further final tests/exams.

Table 19: Overview of the allocation of ECTS on the basis of completion of modules and successful tests and exams[17].

Module	Beginner 1 ECTS	Beginner 2 ECTS	Master's level 7: total ECTS
1. Data acquisition	6	15	
2. Data management	6	15	
3. Data analysis	6	15	
4. Data visualization	12	15	
Total	**30**	**60**	**90**

Upon the final exam, students will be asked to submit the MOOC evaluation form so they (anonymously if they want) can provide feedback on the MOOC. The evaluation questionnaire will be available from the very beginning of the MOOC, so students can write down feedback/comments throughout the different parts of the MOOC and they will be encouraged to submit the evaluation form upon completion of each main module.

[17] For those who have completed only "Beginner 1", 30 ECTS will be assigned and for those who have completed only "beginner 2", 60 ECTS will be assigned. The entrance test, when allowing direct access to "Beginner 2" level, will grant 30 ECTS advanced credits towards completing the MOOC as a Master's degree. The equivalent in micro-credentials will be reported in the MOOC, given ongoing developments on the ECTS/micro-credentials conversion.

5 REFERENCES

Bologna Working Group (2005). *A Framework for Qualifications of the European Higher Education Area*. Bologna Working Group Report on Qualifications Frameworks (Copenhagen, Danish Ministry of Science, Technology and Innovation). Retrieved from http://ecahe.eu/w/index.php/Framework_for_Qualifications_of_the_European_Higher_Education_Area#Source (accessed 14/05/2021).

Burrough, P. A., McDonnell, R., Lloyd, C. D. (2015). Principles of geographical information systems. 3rd edition. New York, Oxford.

Del Gobbo, G., Pellegrini, M., De Maria, F. (2020). Distance education based on learning outcomes: designing a course in higher education / Didattica a distanza per risultati di apprendimento: un caso di progettazione nell'alta formazione. Form@re - Open Journal per la formazione in rete ISSN 1825-7321, vol. 20, n. 3, pp. 176–195. FUP. DOI: http://dx.doi.org/10.13128/formare-10104. Retrieved from https://oaj.fupress.net/index.php/formare/article/view/10104/9082 (accessed 22/05/2021).

EC (2020a). *European Skills Agenda for Sustainable Competitiveness, Social Fairness and Resilience*. EC. Retrieved from https://ec.europa.eu/social/main.jsp?catId=1223 (accessed 23/05/2021).

EC (2020b). COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on achieving the European Education Area by 2025. EC. Retrieved from https://ec.europa.eu/education/resources-and-tools/document-library/eea-communication-sept2020_en (accessed 23/05/2021).

EC (2020c). Digital Education Action Plan (2021-2027). EC. Retrieved from https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en (accessed 23/05/2021).

EC (2020d). *A European approach to micro-credentials – Output of the micro-credentials higher education consultation group – Final report*. EUROPEAN COMMISSION Directorate-General for Education, Youth, Sport and Culture Directorate B — Youth, Education and Erasmus+ Unit B.1 — Higher Education, European Commission B-1049 Brussels. ISBN: 978-92-76-22977-3. Retrieved from https://op.europa.eu/fr/publication-detail/-/publication/7a939850-6c18-11eb-aeb5-01aa75ed71a1 (accessed 14/05/2021).

ECA (2021). Dublin Descriptors. *European Consortium for Accreditation (ECA) Website*. Retrieved from http://ecahe.eu/w/index.php?title=Dublin_Descriptors (accessed 23/05/2021).

EMC (2019). *The European MOOC Consortium (EMC) launches a Common Microcredential Framework (CMF) to create portable credentials for lifelong learners*. EMC. Retrieved from https://emc.eadtu.eu/images/Press_release_European_MOOC_Consortium_launches_a_Common_Microcredential_Framework.pdf (accessed 23/05/2021).

EMC (2020). *EMC Website*. Retrieved from https://emc.eadtu.eu/ (accessed 23/05/2021).

EU (2015). *ECTS User's Guide 2015*. EU. Retrieved from http://www.ehea.info/media.ehea.info/file/ECTS_Guide/00/0/ects-users-guide-2015_614000.pdf (accessed 23/05/2021).

EU (2015). *ECTS Users' Guide*. European Commission / European Union. Retrieved from https://ec.europa.eu/education/resources-and-tools/european-credit-transfer-and-accumulation-system-ects_en (accessed 15/05/2021).

EU (2020). *Digital Education Action Plan 2021–2027 – Resetting education and training for the digital age*. European Union. Retrieved from https://ec.europa.eu/education/sites/default/files/document-library-docs/deap-communication-sept2020_en.pdf (accessed 14/05/2021).

Haniya S., Paquette L. (2020). Understanding learner participation at scale: How and why. *E-Learning and Digital Media*. 2020; 17(3): 236–252. DOI: https://doi.org/10.1177/2042753019900963.

Iniesto, F., McAndrew, P., Minocha, S., Coughlan, T. (2016). Accessibility of MOOCs: Understanding the Provider Perspective. Journal of Interactive Media in Education, 2016(1): 20, pp. 1–10, DOI: http://dx.doi.org/10.5334/jime.430. Retrieved from https://files.eric.ed.gov/fulltext/EJ1125654.pdf (accessed 22/05/2021).

Kato, S., Galán-Muros, V., Weko. T. (2020). "The emergence of alternative credentials", *OECD Education Working Papers*, No. 216, OECD Publishing, Paris, DOI: https://doi.org/10.1787/19939019. Retrieved from https://www.oecd-ilibrary.org/education/the-emergence-of-alternative-credentials_b741f39e-en (accessed 14/05/2021).

MAUT (2021). A Brief History of MOOCs | MAUT - McGill University. *McGill Association of University Teachers (MAUT) Website*. Retrieved from https://www.mcgill.ca/maut/news-current-affairs/moocs/history (accessed 23/05/2021).

Okabe, A. (2006). Introduction. GIS-Based Studies in the Humanities and Social Sciences. Boca Raton.

Orr, D., Pupinis, M., Kirdulytė, G. (2020). *Towards a European approach to micro-credentials: a study of practices and commonalities in offering micro -credentials in European higher education*. NESET Report, Luxembourg: Publications Office of the European Union. DOI: http://dx.doi.org/10.2766/7338. Retrieved from https://ec.europa.eu/education/sites/default/files/document-library-docs/towards-european-approach-micro-credentials-analytical-report.pdf (accessed 14/05/2021).

Redecker, C. (2017). European Framework for the Digital Competence of Educators: DigCompEdu. Publications Office of the European Union, Luxembourg. DOI: http://dx.doi.org/10.2760/178382. Retrieved from https://ec.europa.eu/jrc/en/digcompedu (accessed 11/06/2021).

Rivas, M. J., Baker, R. B., Evans, B. J. (2020). Do MOOCs Make You More Marketable? An Experimental Analysis of the Value of MOOCs Relative to Traditional Credentials and Experience. *AERA Open October-December 2020*, Vol. 6, No. 4, pp. 1–16. DOI: https://doi.org/10.1177/2332858420973577.

UN (2015). *Transforming our world: the 2030 Agenda for Sustainable Development.* United Nations. Retrieved from https://sustainabledevelopment.un.org/post2015/transformingourworld (accessed 25/04/2021).

Ventista, O. M. (2018). Self-assessment in Massive Open Online Courses. *E-Learning and Digital Media*. 2018; 15(4): 165–175. DOI: https://doi.org/10.1177/2042753018784950.

Wagner, K. (2018). Geographic information systems and glacial environments. Past glacial environments. Amsterdam.

6 APPENDICES

6.1 The structure of the MINERVA questionnaire analysis[18]

Target groups		
Higher education		Labour market
GIS	Cultural heritage	
1	2	3
ID SECTION		
Q1 - Please, identify yourself with one of the following target groups.		
Q2 - Please, specify your country of work.		
Q3 - Please, specify your city of work.		
Q4 - Please, specify the following information. (UNI; FAC; DEP)		
Q5 - What are your fields of teaching?	/	/
/	*Q6 - What are your fields of teaching?*	*Q7 - What are your fields of personal expertise in relation to CH?*
/	/	Q8 - What type of sector do you work at?
/	/	Q9 - What type of institution do you work for?
/	/	Q10 - How many employees work at your institution?
/	*Q11 - What is the main focus of courses you teach in relation to cultural heritage (CH)?*	*Q12 - What is the main focus of your professional work in relation to cultural heritage (CH)?*
/	Q13 - To what extent are you familiar with the topics of geographic information systems (GIS)?	
/	*(PPT PRESENTATION)*	
DEMOGRAPHICS		
Q69 - Please, specify your gender.		
Q70 - Please, specify your age.		
Q71 - Please, specify your level of education.		
BASIC MANAGEMENT (BASICS OF GIS TASKS ORGANIZATION)		
/	Q15 - How important in general is teaching GIS in relation to the following fields of CH? Mark each category from 1 - not important at all to 5 - very important.	Q16 - How important in general is practicing GIS in relation to the following fields of CH? Mark each category from 1 - not important at all to 5 - very important.
Q17 - How much of your teaching is dedicated to geographic information systems (GIS)?		Q18 - How often do you use GIS in your professional work on CH?
/	/	Q19 - What kind of GIS tasks do you handle on your own?
/	Q20 - How often do you need external GIS support to enrich your teaching on CH (e.g. cartographic representation, data analysis)?	Q21 - How often do you need external support of GIS in your professional work on CH (e.g. cartographic representation, data analysis)?
Q22 - What kind of GIS tasks do you outsource (if any)?		
Q23 - What are your main sources for teaching GIS?		/
Q24 - Specify textbooks that you use to teach GIS (add references)?		/
Q25 - Specify online courses that you use to teach GIS (add references)?		/
Q26 - Specify workshops that you use to teach GIS (add references and/or briefly describe)?		/
Q27 - Specify tutorials that you use to teach GIS (add references and/or briefly describe)?		/
Q28 - Specify learning by doing that you use to teach GIS (add references and/or briefly describe)?		/
Q29 - Specify other sources that you use to teach GIS (add references and/or briefly describe)?		/
Q30 – How often do you involve GIS into the following educational forms? Rate from 1 – never to 5 – always.		/
Q31 - Please, specify course(s) where you include GIS into teaching.		/
Q32 – How many students (undergraduate and postgraduate) per year participate at your courses where you teach GIS?		/
Q33 - How do you rate the amount of time dedicated to GIS in your teaching?		/
Q34 - How much of your teaching is dedicated to fields of cultural heritage (CH)?		/
Q35 - How often do you involve CH into the following educational forms? Rate from 1 – never to 5 - always.		/
USAGE OF HARDWARE AND SOFTWARE EQUIPMENT		

[18] Questions in *italics* have multiple answers possible.

Q36 - What kind of hardware/equipment do you use in your teaching?		*Q37 - What kind of hardware/equipment do you use in your professional work?*
Q38 - Which desktop GIS software do you use in your teaching?		*Q45 - Which desktop GIS software do you use in your professional work?*
Q39 - Please, specify commercial (with license) desktop GIS software that you use in your teaching.		Q46 - Please, specify commercial (with license) desktop GIS software that you use.
Q40 - Please, specify non-commercial (freely available) desktop GIS software that you use in your teaching.		Q47 - Please, specify non-commercial (freely available) desktop GIS software that you use.
Q41 - Which online GIS applications do you use in your teaching (including web services such as google maps)?		*Q48 - Which online GIS applications do you use in your professional work (including web services such as google maps)?*
Q42 - Please, specify commercial (with license) online GIS applications that you use in your teaching.		Q49 - Please, specify commercial (with license) online GIS applications that you use.
Q43 - Please, specify non-commercial (freely available) online GIS applications that you use in your teaching.		Q50 - Please, specify non-commercial (freely available) online GIS applications that you use.
Q44 - How often do you use the different types of GIS software in your teaching? Rate from 1 - never to 5 - always.		Q51 - How often do you use different types of GIS software in your professional work? Rate from 1 - never to 5 - always.
USAGE OF GIS FOR DATA MANAGEMENT		
Q52 - What is the scale of your GIS study material?		*Q53 - What is the scale that you work on with GIS?*
Q54 - What kind of GIS data do you manipulate with?		
Q55 - What type of GIS knowledge on data management do you involve in your teaching?		*Q56 - What type of GIS knowledge on data management do you involve in your professional work?*
/	/	*Q57 - What type of GIS knowledge on data management do you need to improve for your work?*
USAGE OF GIS FOR DATA ACQUISITION		
Q58 - What type of GIS knowledge on data acquisition do you involve in your teaching?		*Q59 - What type of GIS knowledge on data acquisition do you involve in your professional work?*
/	/	*Q60 - What type of GIS knowledge on data acquisition do you need to improve for your work?*
USAGE OF GIS FOR DATA ANALYSIS		
Q61 - What type of GIS knowledge on data analysis do you involve in your teaching?		*Q62 - What type of GIS knowledge on data analysis do you involve in your professional work?*
/	/	*Q63 - What type of GIS knowledge on data analysis do you need to improve for your work?*
Q64 - Do you involve programming into your teaching?		*Q65 - Do you involve programming into your professional work?*
USAGE OF GIS FOR DATA VISUALIZATION AND PRESENTATION OF FACTS/RESULTS		
Q66 - What type of GIS knowledge on data visualization do you involve in your teaching?		*Q67 - What type of GIS knowledge on data visualization do you involve in your professional work?*
		Q68 - What type of GIS knowledge on data visualization do you need to improve for your work?

6.2 Good practices of teaching/training/programme/project

This appendix is a collection of European good practices of teaching/training/programme/project intended to increase the competence of learners in the field of Geotechnologies for Cultural Heritage.

NAME OF THE TEACHING/TRAINING/PROGRAMME/PROJECT SUCCESSFUL EXPERIENCE	***Master in Geographical Information Systems for Territory Monitoring and Management***
LOCATION/GEOGRAPHICAL COVERAGE	*Florence, Italy*
WEBSITE OR SOCIAL MEDIA	*http://www.geografia-applicata.it/master*
WHO IS DEVELOPING/HAD DEVELOPED THE PROJECT?	*Laboratory of Applied Geography (LabGeo) of the University of Florence, SAGAS Department*
BRIEF DESCRIPTION & OBJECTIVES OF THE PROJECT	*The training objective of the Master is to prepare specialists in Geographic Information Systems (GIS) able to address interdisciplinary issues related to monitoring, management and sustainable development of the territory, providing expertise in the technical-disciplinary field of new technologies and the necessary support to knowledge, analysis and decision making with particular regard to the protection and enhancement of environmental and cultural heritage. The training course in presence, lasting one year, is aimed at those who have obtained a master's degree and award the title of second level university master.*
TOOLS AND METHODS USED LEAD TO A SUCCESSFUL OUTCOME	*The Master is divided into four modules that can also be used individually:* • *Geotechnologies: introduction to GIS, remote Sensing, topography and cartography,* • *Environment: monitoring, management, risk prevention,* • *Infrastructures: monitoring, management, risk prevention,* • *Environmental and cultural heritage: monitoring, management, risk prevention.*
TARGET AUDIENCE/FINAL USERS	*Graduates in the following classes: Urban Planning and Territorial and Environmental Planning Sciences, Civil and Environmental Engineering, Biological Sciences, Earth Sciences, Agricultural, Food and Forestry Sciences and Technologies, Environmental and Nature Sciences and Technologies, Geographical Sciences; employees of public bodies and professionals*
OTHER ACTORS/STAKEHOLDERS INVOLVED	*Istituto Geografico Militare (https://www.igmi.org)*
SELECTED TAGS ABOUT THE PROJECT	*Geotechnologies, environment, cultural heritage*
MAIN RESULTS	*Number of students finding job after the final stage*
REPLICABILITY AND/OR UP-SCALING ***What are the possibilities of extending the good practice more widely?***	*The master could be also delivered in e-learning.*
HOW IS IT EVALUATED? ***Confirmation by the beneficiaries that the practice addresses the needs properly. Has the good practice been validated with the stakeholders/final users?***	*Good feedback from students*
LESSONS LEARNED ***What are the key messages and lessons learned to take away from the good practice experience?***	*Learn Geotechnologies skills for the Territory Monitoring and Management, work experience in public administration or in companies at the end of the course*
RELATED RESOURCES THAT HAVE BEEN DEVELOPED ***What training manuals, guidelines, technical fact sheets, posters, pictures, video and audio documents, and/or Web sites have been created and developed as a result of identifying the good practice?***	*Teaching*: *Environmental and cultural heritage: monitoring, management, risk* — *Description*: • Remote sensing applications

prevention	• GIS applied to the analysis of cultural heritage and landscaping • Forest management and Silviculture • GIS for Urban Planning
Environment: monitoring, management, risk prevention	• GIS applied to environmental analysis • Physical geography and applied geomorphology • Seismic risk analysis • Analysis of landslide phenomena
Infrastructure: monitoring, management, risk prevention	• Hydraulic protection of the territory • GIS for the prevention of hydrogeological risk • GIS for network analysis • Transport infrastructure and planning
Work experience, stage	*300 hours*

PHOTOS/IMAGES

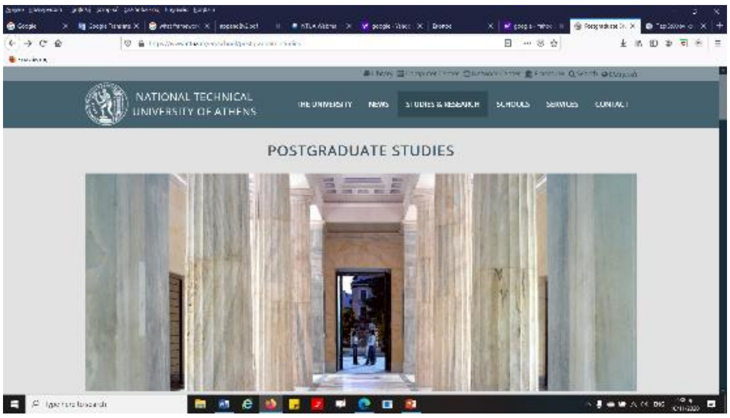
NAME OF THE TEACHING/TRAINING/PROGRAMME/PROJECT SUCCESSFUL EXPERIENCE	***Master in GIScience and Remote Pilot Systems for Integrated Territory and Natural Resources Management***
LOCATION/GEOGRAPHICAL COVERAGE	*Padova, Italy*
WEBSITE OR SOCIAL MEDIA	*https://www.mastergiscience.it* *https://www.facebook.com/MasterGIScience* *https://www.instagram.com/mastergiscience_pd/* *https://twitter.com/MasterGIS_Droni*
WHO IS DEVELOPING/HAD DEVELOPED THE PROJECT?	*University of Padova*
BRIEF DESCRIPTION & OBJECTIVES OF THE PROJECT	*The course trains multi-purpose professionals in the design and management of Territorial Data Infrastructures, webgis, GIS development. These are professionals in GIScience who can find employment opportunities in public administrations, agencies, companies, organizations, as: experts in the use, design, implementation and management of geoportals for the publication of spatial data in accordance with the national rules and European INSPIRE; experts in the compilation of metadata according to the national rules; in the processing of data produced by the public administrations and in the management of Topographic Geodatabases through the use of GeoUML Methodology according to national specifications; in the design and management of webgis made with OpenSource technology and in the development of new GIS applications.* *The Master prepares new GIScience and Geographic Information professionals in different profiles (Geographic Information Manager, Geographic Information Officer, Geographic Knowledge Enabler, Geographic Information Specialist, GeoData Analyst) able to:* *use interdisciplinary approaches, technological solutions and geographic information in order to address complex territorial issues;* *acquire, represent and analyze geographic information in order to spread its expert use in complex decisions;* *manage the transformation of technologies in support of GIScience by directing the identification of appropriate solutions for companies, public administrations, and citizens.*
TOOLS AND METHODS USED LEAD TO A SUCCESSFUL OUTCOME	*The structure of the teachings has been designed to provide the student with a geographical background essential to develop the necessary skills through a reasoned path that starts from the general characteristics of human and physical geography and cartography, and then goes into the understanding of the territory, natural ecosystems and geomorphology before devoting himself to GIScience in the strict sense, devoting ample space to the practical study of the core areas of this discipline:* • *GPS and mobile devices,* • *GIS raster and vector,* • *Geodatabase,* • *Remote sensing,* • *Webgis,* • *Remote control systems,* • *Participatory GIS.*
TARGET AUDIENCE/FINAL USERS	*Recent graduates, civil servants and technicians employed in the public and private sectors, freelancers interested in acquiring advanced training and scientific development are increasingly in demand by public administrations, private and non-profit organizations that have to manage the increase in the availability of geographic information and the rapid development of new geographic data management technologies (from drones to WebGIS to mobile-GIS).*
OTHER ACTORS/STAKEHOLDERS INVOLVED	*Data not available at the time of writing*
SELECTED TAGS ABOUT THE PROJECT	*Geotechnologies, data management, geography*
MAIN RESULTS	*Data not available at the time of writing*
REPLICABILITY AND/OR UP-SCALING ***What are the possibilities of extending the good practice more widely?***	*Data not available at the time of writing*
HOW IS IT EVALUATED? ***Confirmation by the beneficiaries that the practice addresses the needs properly. Has the good practice been validated with the stakeholders/final users?***	*Data not available at the time of writing*

LESSONS LEARNED ***What are the key messages and lessons learned to take away from the good practice experience?***	*This master is an excellent way to update the skills of workers in the field of geotechnologies and environment. It proposes different online courses in order to give everyone the opportunity to participate. In addition, at the end of the course there is a required work experience in public administration or in companies for 450 hours.*
RELATED RESOURCES THAT HAVE BEEN DEVELOPED ***What training manuals, guidelines, technical fact sheets, posters, pictures, video and audio documents, and/or Web sites have been created and developed as a result of identifying the good practice?***	*Data not available at the time of writing*
OTHER LINKS AND REFERENCES	*Data not available at the time of writing*
PHOTOS/IMAGES	*N/A*

NAME OF THE TEACHING/TRAINING/PROGRAMME/PROJECT SUCCESSFUL EXPERIENCE	***Master: Geographic information systems and spatial analysis in history and archaeology***
LOCATION/GEOGRAPHICAL COVERAGE	*Athens University of Economics and Business* *Athens, Greece*
WEBSITE OR SOCIAL MEDIA	*https://eclass.aueb.gr/courses/INF415/*
WHO IS DEVELOPING/HAD DEVELOPED THE PROJECT?	*Markos Katsianis, University of Patras* *Eleni Gadolou, National Hellenic Research Foundation* *Angeliki Chrysanthi, University of the Aegean*
BRIEF DESCRIPTION & OBJECTIVES OF THE PROJECT	• *Understanding of the theoretical implications of GIS as analytical aids in History and Archeology.* • *Learning of basic procedures for recording, processing, analyzing and presenting spatial data using standard GIS software packages and selected application examples.*
TOOLS AND METHODS USED LEAD TO A SUCCESSFUL OUTCOME	*ArcGIS*
TARGET AUDIENCE/FINAL USERS	*University graduates of the country and abroad* *Graduates in humanities*
OTHER ACTORS/STAKEHOLDERS INVOLVED	*Data not available at the time of writing*
SELECTED TAGS ABOUT THE PROJECT	*GIS, history, archaeology, geotagging, 3D*
MAIN RESULTS	*Familiarization with techniques used for acquiring, managing and visualizing archaeological and historical information in space.*
REPLICABILITY AND/OR UP-SCALING ***What are the possibilities of extending the good practice more widely?***	*Life-long learning programs*
HOW IS IT EVALUATED? ***Confirmation by the beneficiaries that the practice addresses the needs properly. Has the good practice been validated with the stakeholders/final users?***	*Student assessment reviews*
LESSONS LEARNED ***What are the key messages and lessons learned to take away from the good practice experience?***	• *Basic principles of Geographic Information Systems (GIS) in Archeology and History are presented.* • *Spatial data structures and geodesy* • *Spatial databases and thematic mapping* • *Digitization of spatial data sets, geo-referencing of images* • *Spatial and thematic querying* • *Exploratory Data Analysis and Geostatistical Methods* • *Spatial Interpolation and Digital Terrain Models* • *Spatial transformations in Vector and Raster datasets* • *Advanced Vector and Raster Functions* • *Map composition*
RELATED RESOURCES THAT HAVE BEEN DEVELOPED ***What training manuals, guidelines, technical fact sheets, posters, pictures, video and audio documents, and/or Web sites have been created and developed as a result of identifying the good practice?***	*Wheatley, D. & Gillings, M., 2003. Spatial Technology and Archaeology: The Archaeological Applications of GIS, Taylor & Francis.* *Conolly, J. & Lake, M. 2006. Geographical Information Systems in Archaeology. Cambridge University Press: Cambridge.* *Usage of the openly available archaeological dataset "Antikythera Survey Data" in the practical tutorials. Dataset DOI: https://doi.org/10.5284/1024569*

PHOTOS/IMAGES	

NAME OF THE TEACHING/TRAINING/PROGRAMME/PROJECT SUCCESSFUL EXPERIENCE	***Interdepartmental Program of Postgraduate Studies*** ***ENVIRONMENT AND DEVELOPMENT*** *It is divided into 3 modules:* • *GEOINFORMATICS* • *ENVIRONMENT AND DEVELOPMENT* • *INFRASTRUCTURES*
LOCATION/GEOGRAPHICAL COVERAGE	*School of Rural & Surveying Engineering* *Athens, Greece* *National Technical University of Athens*
WEBSITE OR SOCIAL MEDIA	*http://environ.survey.ntua.gr/*
WHO IS DEVELOPING/HAD DEVELOPED THE PROJECT?	*Coordination: School of Rural & Surveying Engineering NTUA*
BRIEF DESCRIPTION & OBJECTIVES OF THE PROJECT	*The Interdepartmental Program of Post-Graduates Studies for the Environment Protection and Integrated Development was founded in 2005 by the NTUA, School of rural & surveying Engineering.* • *Its services support the educational and research needs in the fields of environment, culture and the development of regions as well as the multidimensional, dynamic, dialectical relations, interdependencies and interactions at a technical/ technological, economic, social, political and cultural level.* • *The master aims at the interdisciplinary enhancement of the qualified Engineers of NTUA or other universities of the country, or equivalent of foreign learners and other scientists.* • *Its services support the educational and research needs in the fields of environment, culture and the development of regions as well as the multidimensional, dynamic, dialectical relations, interdependencies and interactions at a technical/ technological, economic, social, political and cultural level through cutting-edge technologies, especially IT and GIS.* *The postgraduate program, which is also a pioneering experiment at educational level, has been based on five "keystones":* • *The training is set up around real problems,* • *Interdisciplinary and holistic approach of the issues,* • *Systematic dissemination of the results,* • *Experiential character of the postgraduate program,* • *International character.*
TOOLS AND METHODS USED LEAD TO A SUCCESSFUL OUTCOME	*Qgis/Arcmap*
TARGET AUDIENCE/FINAL USERS	*The master aims at the interdisciplinary enhancement of the qualified Engineers of NTUA or other universities of the country, or equivalent of foreign learners and other scientists.*
OTHER ACTORS/STAKEHOLDERS INVOLVED	*School of Architecture, School of Mining & Metallurgical Engineering, School of Chemical Engineering, School of Civil Engineering, School of Mechanical Engineering, School of Electrical & Computer Engineering*
SELECTED TAGS ABOUT THE PROJECT	*Geoinformatics; environment and development; infrastructures*
MAIN RESULTS	*Data not available at the time of writing*
REPLICABILITY AND/OR UP-SCALING ***What are the possibilities of extending the good practice more widely?***	*Data not available at the time of writing*
HOW IS IT EVALUATED?	*Indicatively, it is mentioned that 98.6% of the graduates work, while 8.6% continue their studies, some in parallel with their work. Regarding the type of employment, 48.57% of the graduates*

Confirmation by the beneficiaries that the practice addresses the needs properly. Has the good practice been validated with the stakeholders/final users?	*are employed, 42.86% self-employed in an employer, 7.14% self-employed who do not employ other staff and 1.43% self-employed who employ other staff. Regarding the type of employment agency, indicatively the largest percentage of graduates work in public services or organizations (42.86%), 27.14% work in private design offices, 7.14% in construction companies and 7.14% in freelancing. 94% of the graduates consider that the ENVIRONMENT AND DEVELOPMENT program helped them find a job or improve their job position.*
LESSONS LEARNED ***What are the key messages and lessons learned to take away from the good practice experience?***	***Compulsory Courses*** • *Introduction to the Sciences of Development and Environment* • *Spatial, Economic, Social and Environmental Dimensions of Development and Planning* • *Environmental Protection* • *Decision Support Systems* • *Environmental Economics Elective Courses* • *Geographic Information Systems and Environment* • *Space Syntax analysis* • *Methods and Techniques for Environmental Observation and Monitoring* • *Methodology and Methods of Geographical Research* • *Water Environment and development* • *Environmental Management and Control Environmental Policies* • *Built Environment and Development* • *Energy and Environment –Clean Technologies* • *Advanced Methods of Digital Remote Sensing* • *Application of Environmental Planning to the Built Environment* • *Fore sight Methods in Spatial Planning*
RELATED RESOURCES THAT HAVE BEEN DEVELOPED ***What training manuals, guidelines, technical fact sheets, posters, pictures, video and audio documents, and/or Web sites have been created and developed as a result of identifying the good practice?***	• *Remote sensing advanced applications* • *GIS applied to the spatial analysis* • *GIS applied of urban landscape* • *GIS for network analysis* • *Space Syntax analysis for urban planning* • *GIS applied to environmental analysis* • *(case study)* • *Physical geography and applied geomorphology* • *Physical risk analysis* • *Management for the development* • *Cultural protection* • *Hydraulic protection of the territory* • *GIS for the prevention of physical risk* • *Forest management and GIS* • *Cultural protection*
PHOTOS/IMAGES	

NAME OF THE TEACHING/TRAINING/PROGRAMME/PROJECT SUCCESSFUL EXPERIENCE	***Geographic Information Systems (GIS) for Archaeologists***
LOCATION/GEOGRAPHICAL COVERAGE	*National and Kapodistrian University of Athens* *Athens, Greece*
WEBSITE OR SOCIAL MEDIA	*https://elearningekpa.gr/courses/gewgrafika-susthmata-plhroforiwn-gis-gia-arxaiologous*
WHO IS DEVELOPING/HAD DEVELOPED THE PROJECT?	*The Training and Lifelong Learning Center of the National and Kapodistrian University of Athens* *Pr. Lilian Karali, Professor of Prehistoric and Environmental Archeology* *Pr. Konstantinos Kartalis, Professor of Environmental Physics, Department of Physics, National and Kapodistrian University of Athens*
BRIEF DESCRIPTION & OBJECTIVES OF THE PROJECT	*The aim of the Program is to acquaint the trainees with the basic principles of Geographic Information Systems and their main applications in archeology. The Program combines theoretical training and practical training with the use of open source QGIS software, which supports a number of applications in archeology, such as management - mapping of archaeological data, combined mapping of topography and archaeological data and locations, recording and analysis in space, mapping of climatic and environmental data, modeling and forecasting of possible positions and relationships, etc.*
TOOLS AND METHODS USED LEAD TO A SUCCESSFUL OUTCOME	*Qgis*
TARGET AUDIENCE/FINAL USERS	*University Graduates Students of the country and abroad* *Graduates of Secondary Education with a work- related subject experience*
OTHER ACTORS/STAKEHOLDERS INVOLVED	*Data not available at the time of writing*
SELECTED TAGS ABOUT THE PROJECT	*GIS; archaeology*
MAIN RESULTS	*Data not available at the time of writing*
REPLICABILITY AND/OR UP-SCALING ***What are the possibilities of extending the good practice more widely?***	*Applicable in the curriculum*
HOW IS IT EVALUATED? ***Confirmation by the beneficiaries that the practice addresses the needs properly. Has the good practice been validated with the stakeholders/final users?***	*Data not available at the time of writing*
LESSONS LEARNED ***What are the key messages and lessons learned to take away from the good practice experience?***	• *Tutorial 1: Introduction* *This section attempts to introduce the basic principles and functions of Geographic Information Systems (GIS) starting from the definition of GIS, the necessity of their use in various scientific disciplines, their historical development as well as their applications both in the research sector and in the public and private sectors.* • *Tutorial 2: GIS Software* *In this section reference is made to the most well-known GIS software listed their advantages and disadvantages. Special emphasis will be given to software open source available for free.* • *Tutorial 3: Data types and basic concepts of cartography* *This section describes the data types (vector and grid, spatial and descriptive), the concept of cartography and maps is introduced, examined the basic characteristics and the way of development and the topic of the background is discussed in relation to digital elevation models.* • *Tutorial 4: Introduction to QGIS software* *This section describes how to install the free software QGIS and its key features. In the context of the section its trainees will become familiar with the graphical interface of the software.*
RELATED RESOURCES THAT HAVE BEEN DEVELOPED ***What training manuals, guidelines, technical fact sheets, posters, pictures, video and audio documents, and/or Web sites have been created and developed as a result of identifying the good practice?***	*Data not available at the time of writing*

PHOTOS/IMAGES

NAME OF THE TEACHING/TRAINING/PROGRAMME/PROJECT SUCCESSFUL EXPERIENCE	***GIS forum Belgrade Serbia***
LOCATION/GEOGRAPHICAL COVERAGE	*Belgrade, Serbia*
WEBSITE OR SOCIAL MEDIA	*http://www.gisforum.rs/*
WHO IS DEVELOPING/HAD DEVELOPED THE PROJECT?	*GIS Center (Belgrade, Serbia)*
BRIEF DESCRIPTION & OBJECTIVES OF THE PROJECT	*Annually, enthusiasts and GIS professionals meet at the GIS Forum conference to exchange knowledge, experiences, and ideas. As in previous years, the GIS Forum will allow different manufacturers of GIS devices, software, and data to present themselves in one place.* *In this way, participants can compare different products and solutions, connect with colleagues who deal with similar jobs, connect with experts who can help develop geoinformation systems, and get acquainted with current trends.*
TOOLS AND METHODS USED LEAD TO A SUCCESSFUL OUTCOME	*Software and hardware product presentations and demonstrations, project and scientific presentation, publishing a GIS Journal.*
TARGET AUDIENCE/FINAL USERS	*All GIS users at the various levels of experience and GIS profile (experts, professionals, beginners, business people, the scientific community, public sector, policy makers, etc.)*
OTHER ACTORS/STAKEHOLDERS INVOLVED	*Numerous sponsors from the business sector*
SELECTED TAGS ABOUT THE PROJECT	*GIS event, forum, GIS journal, networking*
MAIN RESULTS	*The main result is the creation and support of the vibrant emerging GIS community in the Republic of Serbia, sharing knowledge and skills, networking, etc. One should emphasize the publishing an annual issue of the* ***GIS Journal****, which is the only periodical publication in Serbia dedicated predominantly to the GIS topics.*
REPLICABILITY AND/OR UP-SCALING. ***What are the possibilities of extending the good practice more widely?***	*With the GIS community's growth, it is possible to organize more similar events to meet the increased demand for networking and cooperation. These events may have a regional character or be devoted to the narrower topics, contributing to the higher specialization. In this sense, one should mention the DRON FEST manifestation, which has been gathering drone experts from Serbia (http://dronfest.rs/).*
HOW IS IT EVALUATED? ***Confirmation by the beneficiaries that the practice addresses the needs properly. Has the good practice been validated with the stakeholders/final users?***	*The event is evaluated by the positive feedback delivered by the event's participants.*
LESSONS LEARNED ***What are the key messages and lessons learned to take away from the good practice experience?***	*There is a high demand for GIS experts and enthusiasts from the copious field of work and research to work in synergy to improve the overall GIS environment and develop a new project, ideas, teaching and education opportunities, etc.*
RELATED RESOURCES THAT HAVE BEEN DEVELOPED ***What training manuals, guidelines, technical fact sheets, posters, pictures, video and audio documents, and/or Web sites have been created and developed as a result of identifying the good practice?***	*The GIS FORUM is well covered by internet media (web page), including a photo gallery and social media, promo videos, and much more. During the event, a significant number of poster and oral presentations have been presented. Furthermore, the long-lasting result of GIS FORUM is the GIS Journal freely available in the digital form, in which all representations have been printed since 2015.*
OTHER LINKS AND REFERENCES	*http://dronfest.rs/* *https://giscentar.rs/* *http://www.giszurnal.rs*
PHOTOS/IMAGES	*N/A*

NAME OF THE TEACHING/TRAINING/PROGRAMME/PROJECT SUCCESSFUL EXPERIENCE	***Immovable cultural treasure of Serbia – Serbia 3D***
LOCATION/GEOGRAPHICAL COVERAGE	*South and South East Serbia*
WEBSITE OR SOCIAL MEDIA	*http://srbija3d.rs/EN/index.html*
WHO IS DEVELOPING/HAD DEVELOPED THE PROJECT?	*Faculty of Electronics, University of Nis, Teaching Modul for Multimedia Technology – Laboratorija za racunarsku grafiku i GIS (Laboratory for Computer Graphics and GIS)*
BRIEF DESCRIPTION & OBJECTIVES OF THE PROJECT	*"The goal of the project "Platform for 3D digitization of immovable cultural treasure of Serbia" is to make architectural cultural treasure of Southeastern Serbia accessible to a wide public, both national and international. With that aim in mind, the planned activities included the creation of photo-realistic 3D models of the said objects, web page of the project, and the development of web applications that would enable the users to "move" through the digitized objects and observe them from various angles."* *More about: http://srbija3d.rs/EN/project.html/05/12/20*
TOOLS AND METHODS USED LEAD TO A SUCCESSFUL OUTCOME	*"The selected objects were recorded from the air (using an unmanned aircraft) and their interior (where possible) was recorded using a camera with a 360 degree shooting angle. Based on a large number of recordings from all angles, a faithful 3D reconstruction was performed. The resulting 3D model was used for the creation of a graphic application, which enabled easier manipulation of digital objects and their simpler presentation on the internet. Optionally, this application can be adjusted to be used with the appropriate equipment for the virtual reality.* *The idea was to use aerial footage to create a 3D model, and then to use the procedures such as topology, mapping, texturing and lightening in order to transfer it into a graphic surrounding that enables the making of web portals and applications. A 3D model designed in this way is not only faithful to the original, but can also be observed from all angles, which is often impossible in the real world." https://www.srbija3d.rs/EN/project.html/05/12/20*
TARGET AUDIENCE/FINAL USERS	*Students in technologies and cultural heritage regardless of the level of experience, workers in the preservation of cultural heritage, the tourist sector*
OTHER ACTORS/STAKEHOLDERS INVOLVED	*The two cycles of the project have been supported by the Ministry of Culture and Information of the Republic of Serbia, visually impaired persons.*
SELECTED TAGS ABOUT THE PROJECT	*3D model, medieval buildings, south-east Serbia, visually impaired persons*
MAIN RESULTS	*The project's main result is the creation of a significant number of 3D models of sacral (churches and monasteries) and profane (fortresses) medieval and early Ottoman architecture. They are available for users in various filed of work. The project's outputs will serve to popularize the usage of digital technologies for the research and valorisation of cultural heritage and improve the social and economic environment in the underdeveloped region of South-east Serbia.*
REPLICABILITY AND/OR UP-SCALING ***What are the possibilities of extending the good practice more widely?***	*The project offers many opportunities to be upgraded and scaled-up by introducing new sites or extending the geographical range of the project's scope.* *The project has been extended, and in the second stage, the physical models of the digital 3D models have been made using 3D printing technologies. The aim is to bring closer the material cultural heritage to the visually impaired persons.*
HOW IS IT EVALUATED? ***Confirmation by the beneficiaries that the practice addresses the needs properly. Has the good practice been validated with the stakeholders/final users?***	*The project has been evaluated by many visits to the project's web page and the popularity of posts on several social group platforms.*
LESSONS LEARNED ***What are the key messages and lessons learned to take away from the good practice experience?***	*When digitalized and actively popularized, the reach cultural heritage from South-east Serbia's region serves as a power for economic growth and social development.*
RELATED RESOURCES THAT HAVE BEEN DEVELOPED ***What training manuals, guidelines, technical fact sheets, posters, pictures, video and audio documents, and/or Web sites have been created and developed as a result of identifying the good practice?***	*As a result of good practice examples, a significant number of 3D models have been made. They are accompanied by much digital content publically available on the web. Besides, many presentations have been held to promote the project's results.*
OTHER LINKS AND REFERENCES	*https://www.youtube.com/channel/UCeWieDANEm6lVWpgNHOmHZA* *https://www.facebook.com/Modul.Multimedijalne.tehnologije/* *https://www.instagram.com/srbija3d/*

	http://mt.elfak.ni.ac.rs/index.php/sr/
PHOTOS/IMAGES	*N/A*

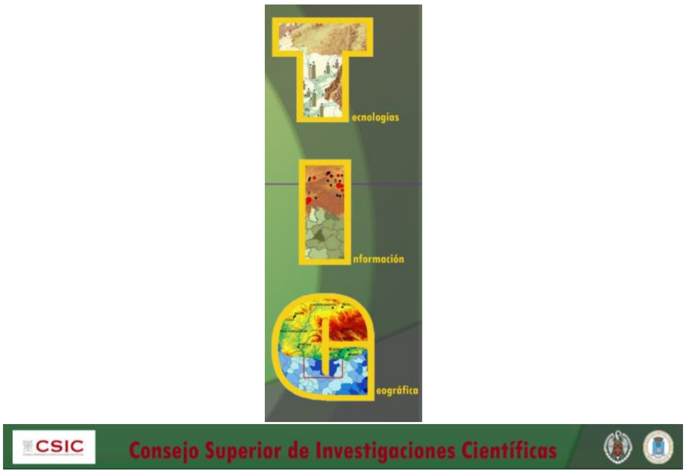
NAME OF THE TEACHING/TRAINING/PROGRAMME/PROJECT SUCCESSFUL EXPERIENCE	***Professional Master in GIS. Itinerary in Geospatial Analysis.***
LOCATION/GEOGRAPHICAL COVERAGE	*Girona, Cataluña*
WEBSITE OR SOCIAL MEDIA	*https://www.unigis.es/master-sig-online/*
WHO IS DEVELOPING/HAD DEVELOPED THE PROJECT?	*UNIGIS Girona is the online training program in GIS of the Information Systems Service Geographic and Remote Sensing (SIGTE) of the University of Girona.*
BRIEF DESCRIPTION & OBJECTIVES OF THE PROJECT	***Description*** *The itinerary in geospatial analysis is directed to the training of GIS analysts. Its main objective is for the student to know and extract the maximum performance from the analytical potential of GIS and its subsequent application in territorial management and planning.* *Although the itinerary is clearly focused on territorial planning and analysis, the workflows, techniques and methodologies involved in a geographic analysis process are easily extrapolated and applicable to other professional fields where spatial analysis is involved.* ***Objectives*** • *Know the main geoprocesses for raster and vector analysis and apply them in real cases.* • *Acquire the necessary skills to know how to process, analyse and interpret satellite images.* • *Know how to analyse and manage territorial resources with a GIS.* • *Know the processes and procedures required by multi-criteria analysis and know how to carry them out.*
TOOLS AND METHODS USED LEAD TO A SUCCESSFUL OUTCOME	*Webinars, public forums, flipped classrooms, specific practices*
TARGET AUDIENCE/FINAL USERS	*Experts in fields:* • *Geography* • *Archaeology* • *Architecture* • *Computing* • *Biology* • *Geology* • *Environment* • *Marketing* • *Tourism* • *Agriculture and forestry sciences* • *Geodesy and topography*
OTHER ACTORS/STAKEHOLDERS INVOLVED	*Data not available at the time of writing*
SELECTED TAGS ABOUT THE PROJECT	*GIS; remote sensing; spatial analysis; multicriteria analysis*
MAIN RESULTS	*Spatial analysis with GIS for:* • *Local administrations* • *Service companies* • *Cadastre* • *Environmental consulting* • *Urbanism* • *Management of natural spaces* • *Marketing companies* • *Tourism management* • *Real estate* • *Public transport* • *Management of transport fleets* • *Public Works* • *Precision farming* • *Emergency management* • *NGO*

	• *Fire management, etc.*
REPLICABILITY AND/OR UP-SCALING ***What are the possibilities of extending the good practice more widely?***	*Practices and cultural heritage case studies, applying the same methodology.*
HOW IS IT EVALUATED? ***Confirmation by the beneficiaries that the practice addresses the needs properly. Has the good practice been validated with the stakeholders/final users?***	*Very well evaluated by students who see their expectations met. Its contents are adjusted to what the labour market demands, as evidenced by the increase in the number of students each year. The program is expanded and diversified to improve its offer.*
LESSONS LEARNED ***What are the key messages and lessons learned to take away from the good practice experience?***	*Promotes self-learning.* *Develops autonomy and problem solving skills of students.*

RELATED RESOURCES THAT HAVE BEEN DEVELOPED
What training manuals, guidelines, technical fact sheets, posters, pictures, video and audio documents, and/or Web sites have been created and developed as a result of identifying the good practice?
	• *Thematic Data Bases*
	• *Links to external resources*
	    ○ *Cartography*
	    ○ *Texts*
	    ○ *Media*
	• *Own videos*
	• *Thematic Units*
	• *Webinars*
	• *Workshops*

OTHER LINKS AND REFERENCES	https://www.udg.edu/es/sigte
PHOTOS/IMAGES	UNIGIS GIRONA FORMACIÓN ONLINE EN SISTEMAS DE INFORMACIÓN GEOGRÁFICA Universitat de Girona SIGTE

NAME OF THE TEACHING/TRAINING/PROGRAMME/PROJECT SUCCESSFUL EXPERIENCE	***Specialisation course: "Geographic Information Systems (GIS) and Remote Sensing. Instrumental Sciences and Research techniques" (4th edition).***
LOCATION/GEOGRAPHICAL COVERAGE	*Madrid, España*
WEBSITE OR SOCIAL MEDIA	*http://cchs.csic.es/es/event/curso-especializacion-sistemas-informacion-geografica-sig-teledeteccion-ciencias-1*
WHO IS DEVELOPING/HAD DEVELOPED THE PROJECT?	*GIS and Digital Humanities Unit of the Center for Human and Social Sciences (CCHS) of the Higher Council for Scientific Research (CSIC). The Complutense University of Madrid (UCM) and the Polytechnic University of Madrid (UPM) collaborate.*
BRIEF DESCRIPTION & OBJECTIVES OF THE PROJECT	*Geographic Information Systems (GIS) and Remote Sensing constitute disciplines in increasing expansion, mainly due to the enormous potential offered by spatial analysis techniques in topics and in very diverse areas, from those related to the environment and natural resources, to the study of socio-demographic changes and urban dynamics, archaeology and cultural heritage, global change, forest management or territorial planning, among others.* *This course is fundamentally practical and is dedicated to learning and handling the basic concepts related to GIS, Remote Sensing and its applications in scientific, technical and business projects, making use of both free and private software to achieve this objective.* *The main objectives are:* • *Know and handle the basic concepts related to GIS, Remote Sensing and its main applications.* • *Work with different types of data and know their structure.* • *Analyse the basic geographic sources of reference, the consumption of web geoservices, the construction of georeferenced databases, query techniques, cartographic visualization, spatial analysis applied to different topics (environmental, agricultural and forestry, landscape, cadastre, heritage, etc.).* • *Attend to the digital processes of satellite images, understand the extraction of information from raster geodata.* • *Apply GIS and Remote Sensing in scientific, technical and business projects.*
TOOLS AND METHODS USED LEAD TO A SUCCESSFUL OUTCOME	*Face-to-face classes, practical exercises, continuous assessment.*
TARGET AUDIENCE/FINAL USERS	*Professionals from public and private entities, postgraduates and engineers. Students of: Earth Sciences, Engineering and Social Sciences, Geography, History, Archaeology, Agronomy, Hydrology, Biology, Geomatics, Environmental Sciences and other professionals interested in the management of georeferenced information and geographic information technologies.*
OTHER ACTORS/STAKEHOLDERS INVOLVED	*Complutense University of Madrid (UCM) and Polytechnic University of Madrid (UPM)*
SELECTED TAGS ABOUT THE PROJECT	*GIS; remote sensing and images analysis; spatial analysis; thematic cartography; geodata*
MAIN RESULTS	*Train professionals in GIS who apply these tools in areas such as:* • *Local administrations* • *Service companies* • *Cadastre* • *Environmental consulting* • *Urbanism* • *Management of natural spaces* • *Tourism management* • *Transport* • *Public Works* • *Precision farming* • *Emergency management*
REPLICABILITY AND/OR UP-SCALING ***What are the possibilities of extending the good practice more widely?***	• *Translate in English* • *Change the face-to-face model to distance learning* • *Shift focus to management of cultural heritage*
HOW IS IT EVALUATED?	*Well rated by students as it enhances their GIS training and has made it possible to apply this*

Confirmation by the beneficiaries that the practice addresses the needs properly. Has the good practice been validated with the stakeholders/final users?	*tool to various fields.*
LESSONS LEARNED ***What are the key messages and lessons learned to take away from the good practice experience?***	• *Enhance self-learning.* • *It is based on problem solving.*
RELATED RESOURCES THAT HAVE BEEN DEVELOPED ***What training manuals, guidelines, technical fact sheets, posters, pictures, video and audio documents, and/or Web sites have been created and developed as a result of identifying the good practice?***	*Handbook published by two of the course teachers: Del Bosque, I.; Fernández, C.; Martín Ferrero, L. y Pérez, E. (2012): Los SIG y la investigación en Ciencias Humanas y Sociales, Madrid, CSIC. Course guidelines:* • *Concepts and foundations of GIS* • *Organization and data modeling* • *Geospatial data management* • *Queries and data recovery* • *Spatial analysis* • *Generation of thematic cartography* • *Remote sensing and image analysis* • *GIS on the Internet: IDE* • *Final project*
OTHER LINKS AND REFERENCES	http://cchs.csic.es/es/service-unit/unidad-sistemas-informacion-geografica-humanidades-digitales-sigyhd
PHOTOS/IMAGES	

NAME OF THE TEACHING/TRAINING/PROGRAMME/PROJECT SUCCESSFUL EXPERIENCE	***Master Digital Geography***
LOCATION/GEOGRAPHICAL COVERAGE	*Saint-Étienne and Lyon, France*
WEBSITE OR SOCIAL MEDIA	*https://mastergeonum.org/*
WHO IS DEVELOPING/HAD DEVELOPED THE PROJECT?	*Jean Monnet University – Saint-Étienne, Université Lumière Lyon 2, Ecole Normale Supérieure de Lyon* *EVS lab – UMR 5600 - CNRS*
BRIEF DESCRIPTION & OBJECTIVES OF THE PROJECT	*The master's degree come within the scope of the renewed landscape of geographic data sciences. Anchored in the field of geomatics, it trains specialists in methods and uses of geographic information management and representation. These specialists are capable of leading digital projects in cities and territories.* *The Master's program is organized around a kernel of necessary skills to master principles, methods and practices of geodata modelling, but also geographic information analysis and visualization. It integrates lessons in quantitative methods, data structures and algorithms.* *The main skills acquired by students at the end of this two-years Master's program are:* • *Know and implement theoretical concepts of cartography, GIS and spatial analysis;* • *Master methods of data acquisition and management and formats of geodata (RDBMS, Spatio-temporal databases, massive data and data mining);* • *Master methods of geographic data processing (GIS, remote sensing, spatial analysis, quantitative and qualitative data analysis, simulation);* • *Master geographic data visualization and dissemination methods (dynamic cartography, GeodataViz, 3D, virtual and augmented reality, Geoweb);* • *Know and implement principles of algorithmic, programming, tasks automatisation and WebMapping;* • *Know how to apply geomatic knowledge in a professional environment;* • *Implement collaborative work and manage a project;* • *Master the English vocabulary of the geomatics field and be able to participate in a professional discussion in English.*
TOOLS AND METHODS USED LEAD TO A SUCCESSFUL OUTCOME	*Face-to-face classes* *Self-learning by comparing software functions (in several proprietary and open source software)* *Team works on concrete studies cases* *Practical exercises* *Continuous assessment* *2 five-months internships* *Writing in a Wiki:* *https://www.univ-st-etienne.fr/wikimastersig/* *Posts publication:* *https://mastergeonum.org/category/la-carte-de-la-semaine/* *The master has its own eLearning platform:* *https://ead-shs.univ-st-etienne.fr/claroline/course/index.php?cid=M2SIG* *The master has its own Discord server.*
TARGET AUDIENCE/FINAL USERS	*Target audience:* • *Bachelor's degree in geography or town and country planning, environmental sciences and computer science,* • *Possibly other academic disciplines with refreshers courses.* *Final users:* • *Engineering offices, service and analysis companies;* • *Network management companies (transport, water, telephone);* • *Local authorities and natural parks;* • *Training structures;* • *Teaching and research institutions.* *In different fields: environment, risk, town and country planning, urban planning, transport, communication, cultural heritage.*
OTHER ACTORS/STAKEHOLDERS INVOLVED	*LIRIS lab - UMR 5205 – CNRS* *Many GIS professionals are involved in the Master*

SELECTED TAGS ABOUT THE PROJECT	*Geomatics, geographic information systems, geospatial database, cartography, remote sensing*
MAIN RESULTS	*High employability rate:* *https://mastergeonum.org/2019/05/26/linsertion-des-diplomes-du-master-geonum-promotions-2017-et-2018/#more-1227*
REPLICABILITY AND/OR UP-SCALING ***What are the possibilities of extending the good practice more widely?***	*Add more contents relative to cultural heritage.* *Reinforce international dimension.*
HOW IS IT EVALUATED? ***Confirmation by the beneficiaries that the practice addresses the needs properly. Has the good practice been validated with the stakeholders/final users?***	*Well rated by students*
LESSONS LEARNED **What are the key messages and lessons learned to take away from the good practice experience?**	*Data not available at the time of writing*
RELATED RESOURCES THAT HAVE BEEN DEVELOPED **What training manuals, guidelines, technical fact sheets, posters, pictures, video and audio documents, and/or Web sites have been created and developed as a result of identifying the good practice?**	*Each year students enrich the wiki of the Master.* *A glossary:* *https://www.univ-st-etienne.fr/wikimastersig/doku.php/glossaire:accueil (RF)* *https://www.univ-st-etienne.fr/wikimastersig/doku.php/english:glossary (EN)* *https://www.univ-st-etienne.fr/wikimastersig/doku.php/fonctions:accueil (FR)*
OTHER LINKS AND REFERENCES	*N/A*
PHOTOS/IMAGES	*N/A*

NAME OF THE TEACHING/TRAINING/PROGRAMME/PROJECT SUCCESSFUL EXPERIENCE	***GIS for spatial planning 1 and 2*** *Study programme and level:* *Master of Geography programme, Regional planning, year 1 and 2*
LOCATION/GEOGRAPHICAL COVERAGE	*Koper/Capodistria, Slovenia*
WEBSITE OR SOCIAL MEDIA	*https://www.fhs.upr.si/en/departments/geography* *https://www.fhs.upr.si/sl/studij/1-stopnja/sl/studij/1-stopnja/geografija/geo1predm*
WHO IS DEVELOPING/HAD DEVELOPED THE PROJECT?	*Department of geography, Faculty of Humanities, University of Primorska, Koper, Slovenia*
BRIEF DESCRIPTION & OBJECTIVES OF THE PROJECT	*At the end of the course students will be able to use geographical knowledge in combination with methods from GIS within different fields of spatial planning, such as resolving conflicts in space usage with help of GIS, spatial evaluation using GIS and the use of GIS as a support for decision-making and placement of new activities in space.* *They are introduced to the basics of spatial planning, spatial planning system and individual good practices examples at national and European levels. Students will try to solve advanced spatial problems independently. They will learn about the most common spatial planning problems and try to critically solve these problems using the obtained knowledge.*
TOOLS AND METHODS USED LEAD TO A SUCCESSFUL OUTCOME	• Quantitative statistical methods • Basics of geographical information systems (GIS) • Students learn to use computer software for data analysing (Excel, SPSS or other) and GIS software packages (QGIS, ArcGIS or other) • Different kinds of spatial information and the way how to digitalise them • The fundamental cartographic principles to be able to design thematic maps by using appropriate programme tools • Statistical methods in GIS • An introduction to the statistical programme R • An analysis of spatial occurrences using statistical methods • Basics of spatial statistics
TARGET AUDIENCE/FINAL USERS	*The study program is designed for students who have completed a undergraduate program in geography. It is a compulsory study program, 15 hours of lectures and 30 hours of tutorials both study years.*
OTHER ACTORS / STAKEHOLDERS INVOLVED	*Data not available at the time of writing*
SELECTED TAGS ABOUT THE PROJECT	*Regional planning, urban planning, land use analyses, regional analyses, cultural geography, resolving conflicts in space usage with help of GIS, spatial evaluation using GIS.*
MAIN RESULTS	*Data not available at the time of writing*
REPLICABILITY AND/OR UP-SCALING. ***What are the possibilities of extending the good practice more widely?***	*The master could be also presented in e-learning.*
HOW IS IT EVALUATED? ***Confirmation by the beneficiaries that the practice addresses the needs properly. Has the good practice been validated with the stakeholders/final users?***	*Good feedback from students.*
LESSONS LEARNED ***What are the key messages and lessons learned to take away from the good practice experience?***	*At the end of the course students will be able to use geographical knowledge in combination with methods from GIS within different fields of spatial planning, such as resolving conflicts in space usage with help of GIS, spatial evaluation using GIS and the use of GIS as a support for decision-making and placement of new activities in space. Students will be able to perform an independent professional work in the field of spatial planning, using cartographic and statistical methods in combination with computerized geographic information systems.*
RELATED RESOURCES THAT HAVE BEEN DEVELOPED ***What training manuals, guidelines, technical fact sheets, posters, pictures, video and audio documents, and/or Web sites have been created and developed as a result of identifying the good practice?***	*Data not available at the time of writing*

OTHER LINKS AND REFERENCES	*N/A*
PHOTOS/IMAGES	*N/A*

NAME OF THE TEACHING/TRAINING/PROGRAMME/PROJECT SUCCESSFUL EXPERIENCE	***Geographic Information Systems*** *Study programme and level:* *Second-cycle (Master's) study programme in Geography*
LOCATION/GEOGRAPHICAL COVERAGE	*Maribor, Slovenia*
WEBSITE OR SOCIAL MEDIA	*http://www.ff.um.si/oddelki/geografija/* *http://www.ff.um.si/oddelki/geografija/studijski-programi.dot*
WHO IS DEVELOPING/HAD DEVELOPED THE PROJECT?	*Department of Geography, Faculty of Arts, University of Maribor*
BRIEF DESCRIPTION & OBJECTIVES OF THE PROJECT	*The course is designed to enable students to upgrade basic knowledge and skills of programme GIS 1 and its use, obtained during undergraduate study.* *Students acquire the methods of spatial analysis of vector and raster data. They learn about the methods of searching for links between multiple spatial numerical and descriptive variables. Students acquire the manufacturing method of synthesis of thematic maps and modelling of spatial variables. In selected cases they produce an exercise using their acquired knowledge.*
TOOLS AND METHODS USED LEAD TO A SUCCESSFUL OUTCOME	• *Basic methods of GIS* • *Processing and visualization of space data* • *Quantitative analysis of relationship between geographical elements within GIS* • *Methods of thematic cartography with selected software* • *Spatial analysis* • *Modelling in spatial database* • *Spatial database application on selected case*
TARGET AUDIENCE/FINAL USERS	*The study program is designed for students who have completed an undergraduate program in geography. It is a compulsory study program, 15 hours of lectures and 30 hours of tutorials.*
OTHER ACTORS/STAKEHOLDERS INVOLVED	*Data not available at the time of writing*
SELECTED TAGS ABOUT THE PROJECT	*Regional planning, urban planning, regional analyses, cultural geography, landscape evaluation.*
MAIN RESULTS	*Data not available at the time of writing*
REPLICABILITY AND/OR UP-SCALING ***What are the possibilities of extending the good practice more widely?***	*The master could be also presented in e-learning, the GIS study program provides for 105 individual work for each student.*
HOW IS IT EVALUATED? ***Confirmation by the beneficiaries that the practice addresses the needs properly. Has the good practice been validated with the stakeholders/final users?***	*Good feedback from students.*
LESSONS LEARNED. ***What are the key messages and lessons learned to take away from the good practice experience?***	*Teaches technology that is useful in working in public administration and in companies. Students are trained to use different methods of spatial analysis and modelling in Spatial database and know how to interpret the obtained results.*
RELATED RESOURCES THAT HAVE BEEN DEVELOPED ***What training manuals, guidelines, technical fact sheets, posters, pictures, video and audio documents, and/or Web sites have been created and developed as a result of identifying the good practice?***	*Data not available at the time of writing*
OTHER LINKS AND REFERENCES	*N/A*
PHOTOS/IMAGES	*N/A*

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