With the support of the Erasmus+ Programme of the European Union Sector Skills Alliances N° 591991-EPP-1-2017-1-IT-EPPKA2-SSA-B

D 4.2 – EO and related curricula

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Work package / Task:

WP4 - Designing GI and EO curricula in support of Copernicus
T4.2 - Design of EO and related curricula

Short Description:

To cover the broad area of EO*GI and in particular to respond to (future) skills requirements of the sector including from industry and other non-academic actors it is necessary to design dedicated curricula. The approach links the curricula to the main business processes and occupational profiles identified in the previous task (WP4, T4.1)). The curricula consist of modules, courses and/or lectures/assignments. Curricula should be easily extendible or revisable and thus be built in a modular way. They will be conceived in such a way that they can be modified and updated adaptively in view of technological and non-technological developments.

Keywords:

Academic curricula, VET curricula, occupational profile, educational offer, EO*GI

Dissemination Level		
PU	Public	
RE	Restricted to other programme participants (including Commission services and project reviewers)	X
CO	Confidential, only for members of the consortium (including EACEA and Commission services and project reviewers)	

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Executive Summary

The report presents preparatory activities, the curriculum design approach and methodology developed, and activities executed for delivery of EO*GI educational offers. Based on the identified business processes in Task 4.1, in total 42 educational offers have been designed by 13 project partners and reviewed by 20 reviewers. Designed educational offers are listed in the document and available on provided links.

Based on previous project documents (WP1 deliverables) and additional analysis, great variety has been confirmed in curriculum design as well as the interdisciplinary nature of EO*GI knowledge and skills, which are implemented in almost all professions today. Therefore, relying on the EO4GEO developed BoK and CDTool, educational offers are created to serve as building bricks for creation of curricula at different levels.

The educational offer designed based on the presented approach, provides the basis for innovation in training activities and mobility programs.

The upgraded Report (version 2.0) provides information on further development of EO4GEO educational offer relying on Work package 5 developed courses and trainings in three predefined sub-sectors, and provides information related to questions (comments) raised by Commission.

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Acronyms

Acronym	Description
EO	Earth Observation
GI	Geographic Information
BoK	Book of Knowledge
CDTool	Curriculum Design Tool
BSc	Bachelor of Science
MSc	Master of Science
VET	Vocational Education Training
MOOC	Massive Open Online Courses
EQF	European Qualifications Framework
ISCO	International Standard Classification of Occupations
ESCO	European Skills, Competences, Qualifications and Occupations
ILO	International Labour Organization

Glossary

Bloom's Taxonomy is a classification of thinking or cognitive skills, which is often used in the design of educational, training and learning processes, and especially in the definition of learning outcomes. Bloom's Taxonomy consist of six levels of thinking skills, ranged from lower order thinking skills to higher order thinking skills.

Body of Knowledge (BoK) is the complete set of concepts and relations between them, that make up a professional domain, (in this case EO*GI BoK) and the related learning outcomes as defined by the relevant learned society or a professional association.

European Credit System for Vocational Education and Training (ECVET) have common instruments helping individuals in transfer, recognition, and accumulation of their assessed learning outcomes, to achieve a qualification or to take part in lifelong learning.

The term **Earth Observation (EO) related services** is taken to mean any geo-spatial information service activity which in some way involves data coming from EO satellites (including meteorological satellites) i.e. any satellite with one or more sensors that measure parameters coming from the earth's surface or atmosphere, aerial or terrestrial photogrammetry. The involvement may be direct i.e. processing or distributing imagery or indirect i.e. consultancy based around knowledge of the imagery or its use. It starts from the point where imagery is transmitted to the ground, so it does include reception and processing of imagery but does not include construction of ground stations or the satellites delivering the data. Note that it includes all geo-spatial information services activities where satellite EO data has been used and so extends to downstream information processing of geospatial information where data being used has been derived from EO imagery possibly in combination with other data types.

European Qualifications Framework (EQF) is defined by 8 levels of descriptors that indicate the learning outcomes relevant to qualifications in any system of qualifications.

Geographic Information (GI) is the data of a geographic location combined with non-spatial information (e.g. statistical data) and their representation as a map.

Massive Open Online Courses (MOOC) are free online courses available and provide an affordable and flexible way to learn new skills, advance your career and deliver quality educational experiences at scale.

Vocational Education and Training (VET) is a key element of lifelong learning systems equipping people with knowledge, know-how, skills and/or competences required in particular occupations or more broadly on the labour market.

The term **Educational offer (EO)** is introduced for the inclusion of academic, as well as vocational education and training under the same umbrella of curriculum design. Although the term curriculum may have a strong academic connotation, an educational offer design in the EO4GEO project is not only restricted to academic study programmes, but also further extended to vocational educational training and courses. So, in this context, an educational offer can be a study programme or a complete academic degree, comprised of modules, courses, and lectures, or it can be just a single lecture or training.

Curriculum (C) is the overall structure and content taught in an educational offer item at any level of granularity: study programme, module, course or lecture.

1. Introduction

1.1. EO4GEO project

EO4GEO is an **Erasmus+ Sector Skills Alliance** gathering **25 partners from 13 EU countries**, most of which are part of the **Copernicus Academy Network**. Be they from academia, public or private sector, they are all active in the education and training fields of the space / geospatial sector. The project is supported by a strong group of Associated Partners mostly consisting of associations or networks active in space/geospatial domain. The project started on January 1st, 2018, upon approval by the EU Education, Audiovisual and Culture Executive Agency (EACEA) and runs over four years.

EO4GEO **aims to help bridging the skills gap in the space/geospatial sector** by creating a strong alliance of players from the sector/community reinforcing the existing ecosystem and **fostering the uptake and integration of space/geospatial data and services**. EO4GEO works in a **multi- and interdisciplinary** way and applies innovative solutions for its education and training actions including case-based and collaborative learning scenarios; learning-while-doing in a living lab environment; on-the-job training; co-creation of knowledge, skills and competencies; etc.

EO4GEO defines a long-term and sustainable strategy to fill the gap between supply of and demand for space/geospatial education and training taking into account the current and expected technological and non-technological developments in the space/geospatial and related sectors (e.g. ICT). The strategy is implemented by: creating and maintaining an ontology-based Body of Knowledge for the space/geospatial sector based on previous efforts; developing and integrating a dynamic collaborative platform with associated tools; designing and developing a series of curricula and a rich portfolio of training modules directly usable in the context of Copernicus and other relevant programmes, and conducting a series of training actions for a selected set of scenarios in three sub-sectors - integrated applications, smart cities and climate change to test and validate the approach. Finally, a long-term Action Plan will be developed and endorsed to roll-out and sustain the proposed solutions.

For more information on the project please visit http://www.eo4geo.eu/about-eo4geo/.

1.2. Objectives of the work package

Work Package 4 (WP4) "**Designing GI and EO curricula in support of Copernicus**" aims at designing in a systematic way a series of VET curricula and revise existing academic courses based on business processes and occupational profiles to be supported in the context of the Copernicus programme and related activities. The work in WP4 is organised in four tasks that build on each other. Task 4.1 aims at identifying typical tasks and workflows in business processes in the field of Earth observation and related areas and linking them with relevant occupational profiles. Task 4.2 is then analysing these business processes and specify required knowledge and skills grouping them into curricula with specified learning outcomes creating EO4GEO educational offer. Task 4.3 targets the improvement of existing and development of new training material, which will be used inside and

outside of the project while Task 4.4 is dedicated to the development of a mobility programme to promote internship by students and young professionals.

1.3. Objectives of the task

To cover the broad area of EO and GI and in particular to respond to (future) skills requirements of the sector, including industry and other non-academic actors, it is necessary to design dedicated educational offers. The approach links the curricula to the main business processes and occupational profiles identified in the previous task (WP4, T4.1). A specific curriculum consists of modules, courses and/or lectures/assignments. Curricula should be easily extended or revised since they are designed in a modular way. They must be conceived in such a way that they can be modified/updated to accommodate technological and non-technological developments.

The task covered the following activities:

- Analysing existing academic and VET curricula in the space (EO) / geospatial (GI) field,
- Sketching possible structures for dedicated curricula for each of the identified processes and profiles,
- Stimulating the discussion among the education and training providers with feedback sessions from Copernicus users and representatives of the three sub-sectors (see WP5),
- Systematic design of the selected curricula using the BoK on GI and EO and the tools developed in the project (mainly the CDTool),
- Using the Curriculum Design Tool (CDTool) to compare different designs and to organise and manage the respective curricula,
- Preparing and organising a workshop with all the partners and representatives from the space/geospatial sector and the Copernicus programme with the main aim to discuss and reconcile occupational profiles,
- Finalizing the drafting of the curricula based on the discussions during the workshop and other feedback received.

The design of the curricula has involved the education and training providers, along with representatives from the space/geospatial sector and users of the Copernicus data and services. The design required recurrent discussions and iterations. Besides a series of remote sessions to discuss versions of the designed curricula, a dedicated workshop was organised to finalize and agree on the curricula. During the workshop, attention was paid to the specific components that are necessary for covering the three sub-sectors, EO4GEO (2020).

1.4. Purpose of the document

The purpose of the document, including presented analysis, methodology and delivered educational offer in this report is to describe, together with Task 4.1 deliverable D4.1 “Business processes and occupational profiles report”, the EO and related curricula, in the form of educational offers, and provide a platform for next task activities, namely, to prepare improved trainings and mobility programs.

1.5. Structure of the document

The document outlines a range of activities:

- Section 1 includes an introduction to EO4GEO, the objectives of the work package, the objectives of the task, purpose and structure of the document.
- Section 2 provides a short description of the methodology implemented for the realisation of the task.
- Section 3 contains a description of preparatory activities for the design of the EO*GI educational offer. It includes additional analysis of existing academic curricula, education forms and occupational profiles and how to approach the design of educational offers.
- Section 4 lines out the initially created education offers, and their review process
- In Section 5, additional educational offers created after the first version of this report has been compiled and delivered in different educational forms (vocational training, LLL training, OOC, …)
- In Section 6 short conclusions are given.
- The Annex provides a systematization and grouping of business processes, review statistics and analytics.

The document also includes description of preparatory activities aiming to specify an approach to the design of the educational offer and training offered to partners involved in curricula design and design processes resulting in project educational offers.

2. Methodology

The methodology used in the design of EO*GI educational offers relies on previous project activities, especially the BoK and CDTool developed in WP3. These resources have been upgraded and tested in several iterations prior to being used for the design of EO*GI educational offers. A second input for the educational offer design were the business processes identified in T4.1.

The term *educational offer* has been introduced to include both academic and vocational education and training under the same umbrella of curriculum design. Although the term *curriculum* may have a strong academic connotation, an educational offer design in the EO4GEO project is not only restricted to academic study programmes, but also further extended to vocational educational training and courses. Therefore, in this context, an educational offer can be a study programme with a complete academic degree, comprised of modules, courses, and lectures, or it can be just a single lecture. The term *curriculum* refers to the overall structure and content taught in an educational offer item at any level of granularity: study programme, module, course or lecture.

The CDTool supports the process of the educational offer design, and the following definitions apply:

- A *study programme* is a curriculum of one or more courses (usually grouped in modules) aiming at a degree, diploma, or certificate.
- A *module* is a collection of courses grouped for the same reason – courses are executed over the same year or semester or tackle the same topic.
- A *course* is a unit of teaching, a set of lectures, or a plan of study on a particular subject, usually leading to an exam or qualification.
- A *lecture* is an educational talk to an audience intended to display information or teach about a particular subject (also known as lessons or classes).

In the approach to the educational offer design (Figure 1), one goal was that individual units (lectures, courses, trainings, modules) may be used as building bricks for the development of more complex educational offers, modules, or curricula of full programmes. The second goal was to follow the modular approach, in which courses and modules were created generically (without specifying details that tie them to a specific study programme or a specific module), and then used (and possibly further specified) in a concrete case. The third goal was to link the content of a building brick to EO*GI-specific concepts and skills (i.e., learning outcomes, description, prerequisites) contained in the EO4GEO BoK – as a formally described, shared vocabulary of the knowledge and skills constituting the EO*GI domain.

As shown in the Figure 1 there is substantial amount of information which is stored in BoK (upper box in Figure 1) enabling its re-use for design of specific curricula. Building bricks (lecture, course, training, module) content elements: description, prerequisites and learning outcomes are directly reusable, while other offer information which further designer can use as an indicator or direct input.

Figure 1. COURSES (AND MODULES) ARE CREATED GENERICALLY.
THEY ARE REUSED (AND POSSIBLY FURTHER SPECIFIED) IN AN ACTUAL EDUCATIONAL OFFER.

For designing the educational offers, the following preparatory activities have been executed:

- Analysis of previous project deliverables (WP1) and external sources,
- Analysis of identified business processes (T4.1) and their systematization by grouping corresponding learning requirements into possible curricula (educational offers) and
- Training and support provided to project partners in the usage of project tools (together with WP3 partners)

The work of designing educational offers was distributed to thirteen (13) project partners involved in T4.2. Having the goal to ensure a harmonised level of designed educational offer units, a review process has been conducted where almost all designed offers had to undergo multiple individual independent reviews. Based on these reviews, the final educational offers have been specified.

3. Preparatory analysis

3.1. Existing academic curricula

The analysis presented in this section relies on documents which have been created in frame of the EO4GEO project, accessible at the EO4GEO webpage, in particular:

- D1.1 Current supply of space/geospatial education and training V2.1 (June 2018)
- D1.2 Workshop on demand for space/geospatial education and training V1.7 (June 2018)
- D1.3 Demand for space-geospatial education and training and priority occupational profiles V2.0 (December 2018)
- D1.4 Trends and challenges in the space-geospatial sector V2.0 (January 2019)
- D4.1 Business processes and occupational profiles v2.0 (M21 - Sep 19)

Furthermore, relevant European and global organisations documents:

- European Commission (2016): “A new Skills Agenda for Europe” and
- World Economic Forum (2018): “The Future of the Jobs Report 2018”
- World Economic Forum (2020): “The Future of the Jobs Report 2020”

Task T1.1 of the EO4GEO project has identified the supply of academic and vocational education and training in Europe in the space/geospatial sector. The task has analysed the former studies conducted in the sector and currently available courses and modules (rather than whole study programmes) under the academic or vocational curricula of the institutions that participated in the survey.

Annex II in the deliverable D1.1 - *Current supply of space/geospatial education and training* contains the complete list of the training resources collected in the survey. The list contains 163 identified resources – lectures, courses, training packages, training modules, summer schools and webinars. For each resource, the *responsible Organisation, Country, Title, Type of training* and *Accessibility* is stated. Figure 2 shows the tag cloud of terms/words used in the resource titles.

As a general conclusion, in D1.2 - *Workshop on demand for space/geospatial education and training*, it is outlined the demand for soft skills in problem solving, to support user uptake, also with the vision about technological trends and innovation capacity to complement technical skills. There are listed nine main outcomes from the workshop, which dealt as guidelines in the development of educational offers.

In D1.3 - *Demand for space/geospatial education and training and priority occupational profiles* the outcomes of the semi-structured interviews suggest that small and medium sized companies demand personnel with generalist knowledge and a horizontal skillset, and large companies have a more vertical organisational structure with staff working on fragmented tasks and workflows being specialists with fewer contacts with clients. Therefore, being able to bridge horizontal and vertical skillsets will be of future concern for all types of organisations. The ability to bridge horizontal and vertical sets of employee skills is a goal of future educational offerings.

The document D1.4 - *Trends and challenges in the space/geospatial sector* considered the cross-sectoral trends which impact the transformation of the educational world. The lack of infrastructure for processing, storage and transmission, access to data and the need to build competencies to provide operational services were highlighted.

D 4.1 – *Business processes and occupational profiles* introduces the business process modelling notation (BPMN) as useful tool for presenting business processes allowing further identification of characteristics attached to different activities in which geo-spatial information is derived from EO data.

Within the mentioned documents, gaps in current educational offers and the necessary horizontal and transversal skills and knowledge needed by modern experts in EO*GI areas have been identified. Independent university study programs are needed to train various profiles of experts in EO*GI areas (remote sensing, geoinformatics, geomatics). Various VETs of various levels (EQFs) are needed in which existing professionals are trained for specific professional tasks and new methods. Educational offers were produced according to the conducted analysis of presenting business processes and needs for new and specific occupation profiles.

Figure 2. TAG CLOUD OF TERMS/WORDS THAT APPEAR IN NAMES OF RESOURCES LISTED IN ANNEX II OF THE DELIVERABLE D1.1.

As the focus of the survey is on Earth observation and most of the surveyed organizations are academic or research institutions, the tag cloud created from names of the collected resources (Fig. 2) presents rather high presence of the training topics on the remote sensing, Earth data, Sentinel and applications. However, the concrete percentage and actual significance of Earth observation within the existing curricula at the universities remains unknown.

In order to investigate the content of these sources, to better understand the topics they address and to get a broader perspective how these courses fit within the curricula structure, a comparative analysis of existing academic curricula in the space/geospatial field has been conducted. The academic curricula analysed in this section, identified in *D1.1-Current supply of space-geospatial education and training* and extended with curricula's from non-European universities, are focused on level 6 and level 7 of the European Qualifications Framework (EQF) given in Table 1.

Table 1. Educational levels defined by the European Qualifications Framework (EQF)

Level	Knowledge	Skills	Responsibility and autonomy	Type of a study	Duration	Credits (e.g. European Credit Transfer and Accumulation System, ECTS)
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study	Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development.	Bachelor's/undergraduate degree in EO/geomatics	6-8 semesters	180-240 ECTS 360-480 credits (UK) 90-120 credit hours (US) often not standardized for a country
Level 7	Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research Critical awareness of knowledge issues in a field and at the interface between different fields	Specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields	Manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams	Master's degree in EO/geomatics	2-4 semesters	60-120 ECTS 120-240 credits (UK) 30-64 credit hours (US) often not standardized for a country

Study programmes related to the space/geospatial field of the EO4GEO participating institutions, and of some of the European academic institutions were extended with the institutions around the world that offer curricula in English. Institutions covered by the analysis are listed in Table 2.

Table 2. List of analysed academic study programmes in T4.2 (identifier: first two characters stand for education level – 6/7; third and fourth characters stand for Europe or World – EU/WR; last two digits stand for enumeration, ascending)

Identifier	Institution	Location	Education level	Study programme name
L6EU01	University of Ljubljana Faculty of Civil and Geodetic Engineering	Ljubljana, Slovenia	6	Geodesy and Geoinformation
L6EU02	Technical University Wien	Wien, Austria	6	Bachelor programme Geodesy and Geoinformation
L6EU03	Technical University Wien	Wien, Austria	6	Bachelor Programme Environmental Engineering
L7EU01	University of Twente	Twente, Netherlands	7	Geo-information Science and Earth Observation
L7EU02	University of Twente	Twente, Netherlands	7	Geoinformatics
L7EU03	University of Ljubljana Faculty of Civil and Geodetic Engineering	Ljubljana, Slovenia	7	Geodesy and Geoinformation

Identifier	Institution	Location	Education level	Study programme name
L7EU04	Technical University Wien	Wien, Austria	6	Master programme Geodesy and Geoinformation
L7EU05	KU Leuven	Leuven, Belgium	7	Master of Geology
L7EU06	KU Leuven	Leuven, Belgium	7	Master of Bioscience Engineering: Agro- and Ecosystems Engineering
L7EU07	KU Leuven	Leuven, Belgium	7	Master of Geography Profile GIS and Spatial Modelling
L6WR01	University of California, Berkeley	Berkeley, U.S.	6	Minor: Geospatial Information Science and Technology
L6WR02	University of California, Berkeley	Berkeley, U.S.	6	Graduate Certificate in Geographic Information Science and technology
L6WR03	University of Colorado Boulder	Boulder, U.S.	6	GIS and Computational Science - Certificate
L6WR04	University of Colorado Boulder	Boulder, U.S.	6	Remote Sensing Graduate Certificate
L6WR05	University of Michigan	Ann Arbor, U.S.	6	Geospatial Analysis and Mapping
L6WR06	University of Southern California	Los Angeles, U.S.	6	GIS and Sustainability Science Minor
L6WR07	University of Southern California	Los Angeles, U.S.	6	Remote Sensing for Earth Observation Certificate
L6WR08	University of Southern California	Los Angeles, U.S.	6	Spatial Analytics Graduate Certificate
L6WR09	Penn State University	State College, U.S.	6	The Certificate in Remote Sensing and Earth Observation
L6WR10	Penn State University	State College, U.S.	6	The Graduate Certificate in Geospatial Programming and Web Map Development
L6WR11	National University of Singapore	Singapore, Singapore	6	Minor in GIS
L6WR12	National University of Singapore	Singapore, Singapore	6	Geographic Information Science (Graduate Certificate)
L6WR13	Peking University	Beijing, China	6	Space Science and Technology
L6WR14	Peking University	Beijing, China	6	Geographical Information Science
L7WR01	University of Southern California	Los Angeles, U.S.	7	Geographic Information Science and Technology
L7WR02	University of Southern California	Los Angeles, U.S.	7	Spatial Data Science
L7WR03	Penn State University	State College, U.S.	7	The Master of Geographic Information Systems
L7WR04	National University of Singapore	Singapore, Singapore	7	Master of Science in Applied Geographic Information Systems
L7WR05	National Central University	Taipei, Taiwan	7	Master of Science Program in Remote Sensing Science and Technology
L7WR06	Peking University	Beijing, China	7	Photogrammetry and Remote Sensing
L7WR07	Peking University	Beijing, China	7	Cartography and Geographic Information System
L7WR08	University of Melbourne	Melbourne, Australia	7	Master of Engineering (Spatial)

The extensive analysis was conducted in three steps: (1) identification of curricula that deal with EO themes (2) structuring the curricula parts (modules) related to (a) concepts and (b) topics covered, and (3) courses assigned to the curricula parts defined by topics and variation-finding within the examined programmes. Such analyses were conducted for (1) bachelor's/undergraduate studies in the space/geospatial field, (2) bachelor's/undergraduate studies in fields related to the space/geospatial field, (3) master studies in space/geospatial field, and (4) master studies in fields related to the space/geospatial field.

A database of existing curricula was set up for describing different study programmes related to EO and GI up to the level of courses and their objectives/skills/outcomes. The focus is on the identification of those courses/modules/study programmes which are candidates to become part of the EO*GI curriculum in original or modified form. The current database encompasses structured data at three levels (programme, modules and courses) supplemented with short content description and/or learning objectives or outcomes (in terms of what one should know or be able to do).

Based on the database content and prior to step 2 of the analysis, tag cloud visualisations of word frequency were conducted for the course names and learning objectives of the selected programmes listed in Table 2. Fig. 3 presents a tag cloud visualisation of the course names, which, similarly to the visualisation presented in Fig. 2, again emphasizes terms and concepts mostly related to the remote sensing, geospatial data, GIS, and computer science. This visualisation, however, directs the conceptual structure of the programme courses to the core modules, domain modules, and specific modules, which are used for conceptualisation of the study programmes at a later stage.

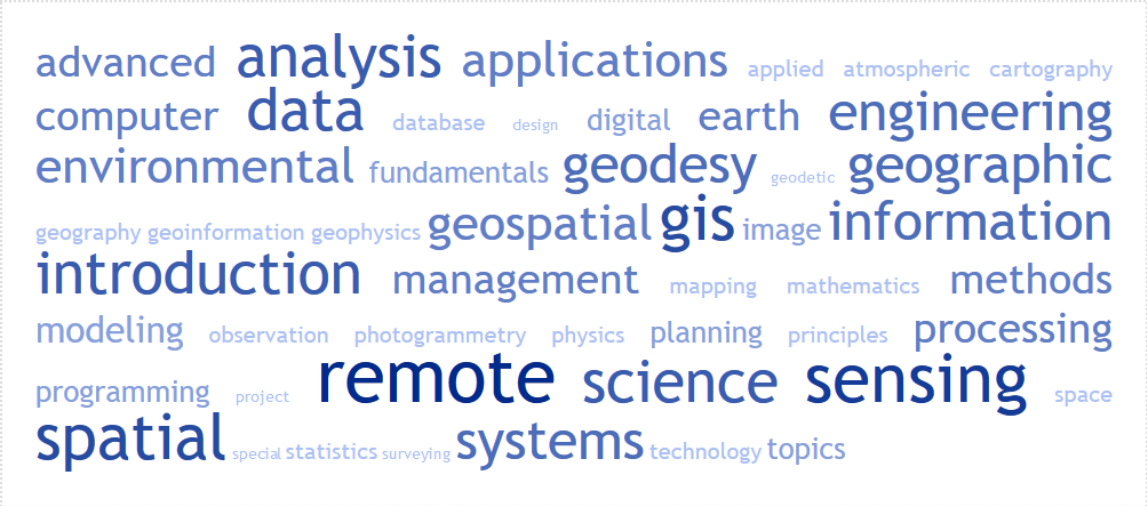

Figure 3. TAG CLOUD OF WORDS THAT APPEAR IN COURSE NAMES

On the other side, the tag cloud of the learning objectives of the examined courses (Fig.4) does not point to standardised knowledge included in the study programmes or skills expected as the learning outcomes. Moreover, course objectives are loaded with general concepts and universal skills.

Figure 4. TAG CLOUD OF TERMS THAT APPEAR IN COURSE ABSTRACTS/LEARNING OBJECTIVES

Table 3 presents the structured curricula categories identified within the study programmes of the level 6 and level 7 in space/geospatial field and related fields. Categories of the level 6 study

structures in space/geospatial domain include: *Scientific background, Geoinformatics, Earth Observation, Other - Space Related Topics*.

Table 3. Curricula parts structured by the topics covered in the examined study types:

Level 6 study in the space/geospatial field			
Scientific background	Geoinformatics	Earth Observation	Other - Space Related Topics
Mathematics and geometry	Spatial data acquisition, analysis and modelling	Photogrammetry and applied photogrammetry	Cadastre and spatial data infrastructures
Computer science (concepts, programming, management)	Spatial databases	Remote sensing and applied remote sensing	Spatial laws
Earth science (geodesy, geology, astronomy, geography, etc.)	GIS and applied GIS	Calculation exercises in photogrammetry and remote sensing	Spatial planning and governance
Data analysis and processing	Cartography and topographic models	3D modelling	Social skills and management

Level 6 study in the field related to the space/geospatial field			
Scientific background	Geoinformatics	Earth Observation	Other - Space Related Topics
Mathematics	Spatial data acquisition, analysis and modelling	Remote sensing and applied remote sensing	
Computer science (concepts, programming, management)			
Area of science basics (e.g. physics, geography, (bio)chemistry, ecology)	GIS and applied GIS		Spatial planning and governance
Data analysis and processing			Social skills and management

Level 7 study in the space/geospatial field			
Advanced Science and Engineering	Advanced Geoinformatics	Advanced Earth Observation	Other - Space Related Topics
Mathematics, geodesy and geophysics	Advanced GIS and implementation	Advanced photogrammetry and remote sensing	Spatial data infrastructures and modelling
Earth and atmospheric science	Computer graphics and cartography	Space geodetic techniques	Specific subject-related knowledge
Ecology and environmental science	Mobile and Internet GIS, cloud computing	Advanced satellite-borne data processing and integration	Spatial planning and governance
Advanced data analysis and processing	Software engineering	Advanced 3D modelling	Social skills and management

The category *Scientific background* usually includes basic scientific and basic engineering introductory courses, such as *Mathematics and geometry, Computer science (concepts, programming, management), Earth science (geodesy, geology, astronomy, geography, etc.), Data analysis and processing*. The knowledge specific categories at the level 6 at the study in space/geospatial sector focus on *Geoinformatics* and *Earth observation*. Courses of those categories teach basic principles of photogrammetry, remote sensing for studying processes in the system Earth and its users within a system-based approach. *Geoinformatics* comprise skills and knowledge related to the geoinformation science and Geographical information systems (GIS). Such is included in courses like: *Spatial data acquisition, analysis and modelling, Spatial databases, GIS and applied GIS, Cartography and topographic models*. Representative examples of the courses identified in the category *Earth observation* are *Photogrammetry and applied photogrammetry, Remote sensing and applied remote sensing, Calculation exercises in photogrammetry and remote sensing, 3D modelling*. Finally, the category *Other - Space Related Topics* consists of specific courses that teach basic principles of the domain, social skills knowledge and business-oriented courses. Some of the courses are listed here: *Cadastre and spatial data infrastructures, Spatial laws, Spatial planning and governance, Social skills and management*. The studies of the level 6 related to the space/geospatial field most often can be referenced to the same structure identified for the space/geospatial studies. However, each domain study usually further focuses on the specific knowledge in the application domain.

Table 4. Curricula parts *structured* by the common topics covered in the level 6 studies in the space/geospatial field along with the list of existing courses included in the examined programmes

Mathematics and Science for Engineering	Examples of identified courses
Mathematics and geometry	Mathematics, Physics, Software in geodetic engineering, Introduction to Geodetic Engineering, Statistical methods in geodesy, Adjustment computations (L6EU01), Mathematics for Geodesy, Geometry, Physics for Geodesy, Fundamentals of Computer Science for Geodesy and Geomatics Engineering, Introduction to Programming for Geodesy, Geoinformation and Environmental Engineering, Adjustment Computations, Mathematical Methods of Geosciences (L6EU02), Engineering Data Analysis Methods, Observations, Data Analysis and Statistics, Detection and Extraction of Signals from Noise (L6WR03), Computer Science: Data Structures (L6WR04), Introduction to Statistics, Probability and Statistics, Database Systems (L6WR11), The C Programming, An Outline of Earth Sciences, Introduction to Earth Sciences, An Outline of Geosciences, Numerical Computing, Principles of Software Engineering, Introduction to Geomatics (L6WR14)
Computer science (concepts, programming, management)	
Earth science (geodesy, geology, astronomy, geography, etc.)	
Data analysis and processing	

Geoinformatics	Examples of identified courses
Spatial data acquisition, analysis and modelling	Geoinformation (L6EU01), Geoinformation, Implementing a GIS Application (L6EU02), Introduction to Geographic Information Systems, Digital Worlds: An Introduction to Geospatial Technologies, GIS and Environmental Science, GIS and Environmental Spatial Data Analysis, Cartographic Representation, Geographic Information Analysis, Geographic Information Systems, GIS and Environmental Spatial Data Analysis, Web Cartography (L6WR01), Geographic Information Science: Spatial Analytics, GIS in the Social and Natural Sciences, GIS: Spatial Modelling, GIS: Spatial Programming, GIS: Space Time Analytics (L6WR03), Spatial Databases, Spatial Modelling, Cartography and Visualization (L6WR06), Introduction to Applied GIS, GIS Applications, GIS Design and Practices (L6WR11), Advances in Geographical Science, Network and WEBGIS (L6WR13)
Spatial databases	
GIS and applied GIS	
Cartography and topographic models	

Geodesy	Examples of identified courses
Surveying and satellite geodetic measurements	Introduction to Geodetic Engineering, Precise Terrestrial Surveying, GNSS for geodesy, Engineering Survey (L6EU01), Fundamentals of Engineering Geodesy, Satellite Geodesy, Positioning and Navigation using GNSS (L6EU02), Global Navigation Satellite System (GNSS) Receiver Architecture, Astrophysical Instrumentation, Space Instrumentation (L6WR03), Geospatial Applications of Unmanned Aerial Systems, (L6WR09), The Earth Gravity Field, Application of Geophysics to Engineering, GPS Surveying and Data Processing (L6WR13)
Engineering geodesy	
Navigation and positioning	
Physical geodesy	

Earth Observations	Examples of identified courses
Photogrammetry and applied photogrammetry	Photogrammetry and Remote Sensing, Advanced Remote Sensing of Natural Resources, Topics in Earth System Remote Sensing, Applied Remote Sensing (L6WR01), Observations, Data Analysis and Statistics, Remote Sensing Signals and Systems, Remote Sensing Instrumentation Design, Radar and Remote Sensing, Lidar Remote Sensing, Introduction to Atmospheric Radiative Transfer and Remote Sensing, Fundamentals of Spectroscopy for Optical Remote Sensing, Remote Sensing of the Environment (L6WR03), Remote Sensing Image Analysis and Applications, Topographic Mapping with Lidar, Geospatial Applications of Unmanned Aerial Systems, Fundamentals of Remote Sensing Systems, Inversion Techniques in Remote Sensing, Microwave Radar Remote Sensing, Remote Sensing and Spatial Data Handling, Multispectral Remote Sensing (L6WR09), Remote Sensing for GIS (L6WR07), Digital Analysis of Remotely Sensed Data, Remote Sensing for Earth Observation (L6WR11)
Remote sensing and applied remote sensing	
Calculation exercises in photogrammetry and remote sensing	
3D modelling	

Other - Space Related Topics	Examples of identified courses
Cadastre and spatial data infrastructures	Spatial Planning, Economics and management in geodesy, Property law, Real property records and cadastres, Real estate management and valuation (L6EU01), Cadastre, Constitutional and Administrative Law, Spatial Planning, Private Law, Environmental and Population Economics (L6EU02), Introduction to City Planning, Sustainable Landscapes and Cities (L6WR01), GIS: Project Management (L6WR03), Sustainability Science in the City (L6WR04), Geodesy and Urban Planning (L6WR12), Introduction to the Smart City, Urban Development & Transport Management (L6WR14)
Spatial laws	
Spatial planning and governance	
Social skills and management	

When it comes to EQF level 7 in study programmes of the space/geospatial field, the structure shown in Fig. 5 is a synthesis of the programs being analysed. For example, the structure of the academic master's programme *Geo-Information Science and Earth Observation* (L7EU01) can be divided in *Core module* and *Course domain modules*. Core modules comprise *GIS, data quality and spatial analysis*, *Earth observation*, *Data integration, use and users*. They teach basic principles of remote sensing and GIS for studying processes in the system earth and its users within a system-based approach. On the other side, in *Course domain modules* basic principles of the domain and application of GIS and remote sensing are taught and deepened. The courses in specific domains respond to the specific demands of the professional field, such as *Geoinformatics, Applied Earth*

sciences, Land administration, Natural resources management, Urban planning and management, Water resources and environmental management, etc. Advanced topics on specific research methods and tools for deepening the knowledge and skills are taught, mostly in *Elective courses*. In addition, concept of Master study programme commonly includes research component (*Research profile*) through seminars and Master thesis.

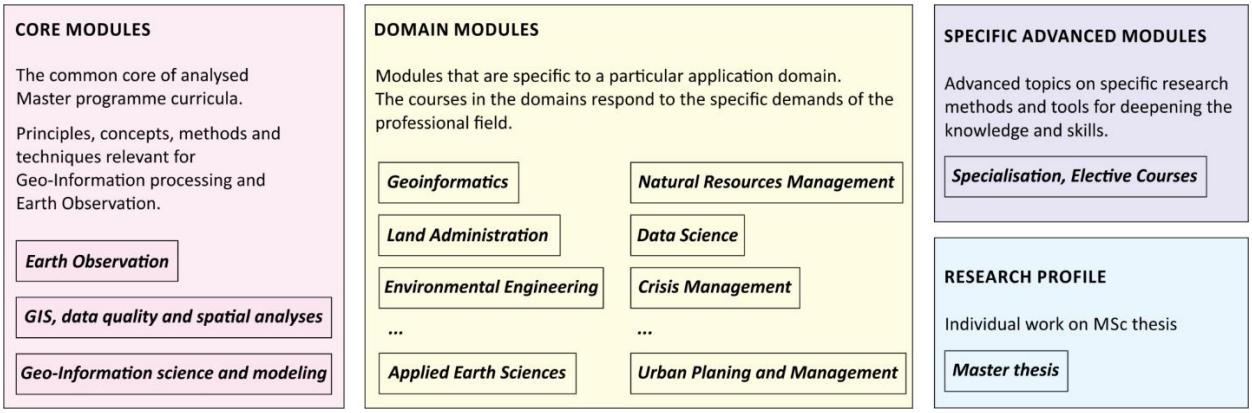

Figure 5. OVERVIEW OF THE OBSERVED STRUCTURE OF THE ACADEMIC MASTER'S PROGRAMME GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

Based on analysis provided in *D1.1. Current supply of space/geospatial education and training* and analysis conducted in this task following conclusions relevant for the development of the EO4GEO educational offer:

- There is great variety of study programs for educating students for many different professions which include EO*GI content in their syllabus.
- EO*GI content varies substantially in volume and content in different educational offers, even on the same topic.
- The EO*GI content is included in syllabus as lectures, courses, modules or even whole study programmes.
- While in Europe the approach in shaping the educational offer is in line with standards defined in Bologna process, worldwide great differences are present.

Those conclusions are therefore one of the inputs for latter definition of approach in creation of EO*GI project educational offer.

3.2. Education modes and occupational profiles

The renewed EU agenda for higher education, adopted by the European Commission in May 2017, identifies four key goals for European cooperation in higher education:

- Tackle future skills mismatches and promoting excellence in skills development,
- Build inclusive and *connected* higher education systems,
- Ensure higher education institutions contribute to innovation,
- Support effective and efficient higher education systems.

To help achieve each of these goals, the Commission proposes specific actions at EU-level, primarily supported by different strands of the Erasmus+ and Horizon 2020 programmes. In particular, the European Commission supports:

- The *exchange of good policy practices between different countries* through the ET2020 higher education working group,
- The Bologna Process, designed to promote the *internationalisation of higher education in Europe through more mobility*, easier recognition of qualifications and streamlined quality assurance mechanisms,
- The *development and use of mobility* and recognition tools, such as the ECTS and ECVET systems and the Diploma Supplement, to increase transparency and facility exchanges in Europe.

3.2.1. Educational modes

Beside the classical modes of academic education at the higher education institutions through the Bachelor, Master and PhD studies, many other modes of education nowadays exist, delivered by academic institutions but also by many others. In parallel, besides delivering an educational offer in physical form, the delivery of educational offer in online digital environment and hybrid forms is increasingly present.

Various kinds of Vocational Education Trainings (VET) are present today on several educational levels, with or without granting academic credits or diplomas/degrees to the successful attendant. Often the term Lifelong Learning (LLL) training is used to describe VET's without certification. The organization and implementation of VET's and LLL trainings depending mainly on national legislation and organization of the educational system. Most European countries have also implemented professional training programs, resulting in a certificate / diploma for successful students. Many of these programs last for 1-2 years and are provided at EQF levels below the BSc programs.

One new mode of education introduced in the last decade are massive open online courses (MOOC) and blended mobility profiling themselves as a promising new form of academic education.

MOOC is a free Web-based distance learning mode that is designed for the participation of large numbers of geographically dispersed students. MOOCs started to develop at the end of the previous decade, and there was a lot of discussion about MOOCs and their future. The recent Covid-19 global pandemic showed the importance of online and therefore also MOOC education. The pros and cons regarding MOOC's are discussed in many research papers and studies (Schuwer et all, 2015, Inamorato dos Santos et all, 2016, or Witthaus et all, 2016). They can be summarized in following points:

The pros for MOOC's are:

- **Free** – courses are mainly offered for free,
- **Quality** – access to courses offered by top universities and top professors, forcing them also continuously to improve lectures and teaching methods, allowing teachers to make the most of classroom time in blended classes,
- **Opportunity** – allowing great number of students to attend courses at universities they cannot enrol,
- **No formal requirements** – beside internet and language knowledge MOOC's do not set formal requirements, therefore supporting multi-culturalism and globalism,

- **Cooperation** – with MOOCs new forms of cooperation are developing between universities, professors and students - connecting people,
- **Sustainable** – are designed to ensure that students keep up with up-to-date and, most often, practical knowledge.

The cons for MOOC's are:

- **Non accreditation** – presently completing a MOOC course does not always result in getting academic credit,
- **Overcrowding** – the professor-to-student ratio is changed and makes discussion with great number of students a challenge, it is difficult to keep track of students' assignments and involvement,
- **Lack of motivation** – combination that MOOCs are free, have no penalty with non-accreditation result in lack of motivation to complete it.
- **High attrition** – MOOCs pros (free, remote, …) create also conditions making it easier for students to drop out. Therefore, quitting rate is much higher than in classical form of academic teaching,
- **Teaching process de-personalization** – teacher – student contact is reduced resulting in a number of problems. It may cause teachers to become nothing more than a "glorified teaching assistants", not the mentor he/she might be striving to be. Problems which may result in limited possibilities to use/implement MOOCs are connected with grading students work – if unreliable grading structure is established, how to approach learners with disabilities, language problems and a poor internet connection. There is also a risk that students will miss the "magic of academy". The presence of MOOCs may also increase the competition with faculties, eventually eliminating them.

Blended mobility is an educational concept that combines physical academic exchange, virtual mobility, and blended learning. The concept is designed to overcome the possible issues related to the funding of the mobility and to break down possible social or psychological barriers of physical mobility. The virtual mobility part of the blended mobility is mostly supported by the communication technologies and IT (e.g. social networks, Moodle, Skype, Adobe Connect, Slack), i.e. platforms and services designed to enable distance learning and collaboration. Besides virtual mobility, blended mobility commonly includes multiple (usually two) short-term intensive physical mobilities, which are focused on problem-solving, especially on solving those problems that are difficult to deal with in a local environment.

In the context of the blended mobility and related to mobility in general, the European Commission identifies a need for the connected education system that could be realised through the student exchange, internationalisation through more mobility and the development of the mobility itself. More precisely, EC explicitly expresses a need for blended mobility, which should be designed (1) to better prepare for the physical mobility, and (2) as a complement to a study programme. Furthermore, an example is given on the blended mobility: 'mobility organised as part of a project with partners abroad or as part of a project on enhancing worked-based learning by making students work on specific projects proposed by enterprises.

3.2.2. Differences in specifying occupational profiles

Being aware that the issue of occupational profiles is not subject of this task, it has impact on design of EO*GI educational offer, especially full study programmes, considering their linking with occupational profiles in international and national occupational classifications.

Today (2021) there is large variety of systems for classifying and specifying occupational profiles. Many countries have used one or several versions (ISCO-08, ISCO-88) of the *International Standard Classification of Occupations* (ISCO) as a model for their own national classifications of occupations. On the other hand, some have retained or developed separate national structures (URI1). A European attempt to standardise the occupational profiles is the *European Skills, Competences, Qualifications and Occupations* (ESCO). It is the pan-European classification of Skills, Competences, Qualifications and Occupations and provides descriptions of 2 942 occupations and 13 485 skills. The aim of ESCO is to support job mobility across Europe and therefore a more integrated and efficient labour market, by offering a “common language” on occupations and skills that can be used by different stakeholders on employment and education and training topics (European Commission, 2017). In both ISCO and ESCO a lack of topics is visible related to space / geospatial field (Earth Observation, Geoinformatics, Remote Sensing) occupations.

The EO4GEO educational offers must consider also the present international and national specifications of occupational profiles. In cases where such definitions differ a lot, the implementation of related study programs may be hampered.

For example, some occupations being specified in ILO, 2012, are related somehow to space / geospatial field (geodesy, photogrammetry, survey, cartography, GIS). They can be found in Major Group 2: Professionals, Sub-major Group 21: 21 PHYSICAL, MATHEMATICAL AND ENGINEERING SCIENCE PROFESSIONALS, Minor Group 214 ARCHITECTS, ENGINEERS AND RELATED PROFESSIONALS; Unit Group 2148 Cartographers and surveyors are (URI2) (Cartographer; Geodesist; Surveyor, geodesic; Photogrammetrist; Surveyor, photogrammetric; Surveyor, land; Surveyor, cadastral). However, occupations which can be found at ESCO portal, and not listed in (URI2) are:

- remote sensing technician (Table 3.2.),
- geographic information systems specialist (Table 3.3.)

This ESCO occupations profile group mainly collects, stores, analyses and visualizes data on the Earth's surface.

The terms Geoinformatics and Earth Observation are not mentioned, *per se*, in ESCO at all, and the term Remote Sensing is mentioned in definition of three occupations in minor group: Minor Group 211: Physical and Earth Science Professionals; Sub-major Group 21: Science and Engineering Professionals; Major Group 2: Professionals:

- 2111 Physicists Astronomers,
- 2112 Meteorologists,
- 2112 Geologists and Geophysicists.

All ESCO skills can be accessed through the existing hierarchy. The ESCO skills pillar distinguishes between:

- skill/competence concepts and
- knowledge concepts by indicating the skill type.

There is, however, no clear distinction between skills and competences. Each of these concepts comes with one preferred term and any number of non-preferred terms and hidden terms in each of the ESCO languages. It also includes an explanation of the concept in the form of a description, scope note and definition. The skills pillar of ESCO does not contain a full hierarchical structure but is structured in four different manners:

- Through their relationship with occupations, i.e. by using occupational profiles as entry point.
- In the part of the transversal knowledge, skills and competences through a skills hierarchy.
- Through relationships indicating how knowledge, skills and competences are relevant to other knowledge, skills and competences (in particular in cases of skill contextualisation).
- Through functional collections that allow to select subsets of the skills pillar.

The National Occupational Classification (NOC) 2016 is the authoritative resource on occupational information in Canada providing a standard taxonomy and framework for dialogue on Labour Market Information. It gathers more than 30,000 occupational titles into 500 Unit Groups, organized according to skill levels and skill types. NOC 2016 updates the National Occupational Classification 2011. It is the nationally accepted taxonomy and organizational framework of occupations in the Canadian labour market. The NOC has been developed and maintained as part of a collaborative partnership between Employment and Social Development Canada and Statistics Canada. Each ten years, structural changes that affect the classification framework, such as the addition of new classes, are considered. The NOC 2016 represents an update and uses the NOC 2011 classification structure. The NOC is designed to classify occupational information from statistical surveys. It is also used in a range of contexts to compile, analyse and communicate information about occupations (URI4). The National Occupational Classification 2016 is based on the NOC 2011 four-tiered hierarchical arrangement of ten occupational groups with successive levels of disaggregation. It contains broad occupational categories, major, minor and unit groups. Occupations related to space / geospatial field (geodesy, photogrammetry, survey, cartography, GIS) can be found in major group: *2 Natural and applied sciences and related occupations*, in follows major / minor / unit groups:

- Major Group 21: *Professional occupations in natural and applied sciences*
  - 211 Physical science professionals
  - 212 Life science professionals
  - 213 Civil, mechanical, electrical and chemical engineers
  - 215 Architects, urban planners and land surveyors

- Major Group 22: *Technical occupations related to natural and applied sciences*
  - 225 Technical occupations in architecture, drafting, surveying, geomatics and meteorology

Profiles are elaborated in much more detail in Canada. The field of remote sensing is strongly represented, in all levels (RS: application specialist, technician, technologist, engineer, research scientist). However, the interdisciplinary component is not adequately covered here either (there is only one occupation profile - RS geologist).

The 2018 Standard Occupational Classification (SOC) system is a federal statistical standard used by federal agencies in the United States to classify workers into occupational categories for the purpose of collecting, calculating, or disseminating data. All workers are classified into one of the 867 detailed occupations according to their occupational definition. To facilitate classification, detailed occupations are combined to form 459 broad occupations, 98 minor groups, and 25 major

groups. Detailed occupations in the SOC with similar job duties, and in some cases skills, education, and/or training, are grouped together (URI3).

The Standard Occupational Classification or SOC helps ensure that occupational data produced across the Federal statistical system are comparable and can be used together in analysis. The SOC is one of several standard classification systems established by the Office of Management and Budget (OMB) for use in the Federal statistical system. All Federal agencies that publish occupational data for statistical purposes are required to use the SOC to increase data comparability across Federal programs.

SOC is a hierarchical classification system to organize all the jobs in the United States. The SOC is created by the Bureau of Labour Statistics (BLS) and used by Federal, State and local government agencies. Although the SOC is a well-structured organization system created by a government agency, we can see some biases reflecting the social, economic, organizational and cultural factors (Suzuki, 2010). Occupations related to space / geospatial field can be found in following mayor groups:

- Major group 1. Architecture and Engineering
  - Cartographers and Photogrammetrists (Bachelor's degree)
  - Surveying and Mapping Technicians (High school diploma or equivalent)

- Major group 15. Life, Physical, and Social Science Occupations
  - Geographers (Bachelor's degree)

There are no such occupation profiles like *Remote Sensing Scientists & Technologists* or *Remote* Sensing *Specialists* in the SOC, but there are job offers for these profiles. A job as a Remote Sensing Specialist falls under the broader career category of Remote Sensing Scientists and Technologists. Job Description for Remote Sensing Scientists and Technologists apply remote sensing principles and methods to analyse data and solve problems in areas such as natural resource management, urban planning, or homeland security. Among other, those specialists and technologists may develop new sensor systems, analytical techniques, or new applications for existing systems (URI4).

This short overview is showing that in ESCO (Europe) and SOC (USA) documents, there is an obvious lack of occupational profiles related to space/geospatial field (Earth Observation, Geoinformatics, Remote Sensing) occupations. Occupations that are directly related to remote sensing and geographic information system only exist in the NOC (Canada). There are occupations that stand alone (remote sensing engineer, remote sensing technician, remote sensing technologist) or associated with some other profession (remote sensing geologist, geographic information system (GIS) forester) for the purpose of interpreting aerial and satellite imagery. The results obtained within the EO*GI are input data into the decision support system on a phenomenon for professional decision-making of individual experts. Although, there are no occupations in SOC directly related to Remote Sensing, there are job offers for these profiles. Job Description for Remote Sensing Scientists and Technologists apply remote sensing principles and methods to analyse data and solve problems in areas such as natural resource management, urban planning, or homeland security. Remote sensing specialists and photogrammetrists often have a bachelor’s or higher degree in geography or a related subject, such as surveying or civil engineering. They are offered various specializations for specific needs (mainly in forestry and agronomy).

Collected and systemized information on education forms and occupational profiles enable following to be concluded relevant for the development of the EO4GEO educational offers:

- EO*GI educational offer developed in frame of EO4GEO project should, as foreseen in project proposal, cover formal and informal modes for various education levels with special attention given to new digital (MOOC) and mobile (blended mobility) modes.
- The educational offers designed within EO4GEO must comply with European standards (such as ESCO). Due to the differences in classification of occupational profiles existing between EU countries and worldwide imposes necessity to develop educational offer in modular form which will enable educational institution to design educational offer from those modular building bricks.
- EO4GEO should provide and has provided initial input to the ESCO system by providing the defined skills defined as part of the BoK on EO*GI. However, additional work is required to group skills in skills-sets linked to particular (new) occupational profiles.

Those conclusions are another input for definition of approach in creation of EO*GI project educational offer and for the LTAP of the Alliance.

3.3. EO*GI Educational offers

3.3.1. Approach and methodology for designing educational offers

Main input for the execution of this task were the business processes and occupational profiles specified by Task 4.1 - *Identifying business processes and occupational profiles.* Task 4.1 results are consolidated in the Deliverable 4.1 *Business processes and occupational profiles report* presenting a detailed description and inventory of identified business processes in EO*GI industry areas and the required occupational profiles in the field of Copernicus, EO*GI and related technological and societal fields.

The methodology for identifying the major business processes uses Business Process Modelling and Notation (BPMN) as a tool and international standard for documenting the details of how a process operates, as a visual representation of a work that shows who is involved in the process, their interactions, and the flow (and processing) of data from task to task. Based on this notation, the business processes are described by diagrams. These descriptions detail the processes which involve EO*GI to get a better insight and understanding of common tasks in the EO*GI sector and job profiles of people working with these types of data and tools. The workflow processes were developed based on a narrative description guide.

Despite great effort invested in Task 4.1 in identifying business processes and related occupational profiles, certain aspects are limiting reliable specification of the content of EO*GI educational offer. Before the business processes presented in Deliverable T4.1 *Business processes and occupational profiles* are used for developing possible structures of EO*GI curricula those limitations should be listed:

- Provided business processes are mostly in the technical field, being logical since EO*GI is a technology driven area and also since the vocation of the consortia members contributing to defining business processes is technical. Still, we postulate that on a certain level and in certain amounts EO*GI subjects are/will be or might be relevant for future professionals also in the social and business disciplines.

- Provided business process are mainly processes, which already exist. Therefore, anticipating future curricula and occupational profiles we rely on result of studies and discussions conducted in other parts of the EO4GEO project like:
    - D 1.1 – Current supply of space/geospatial education and training
    - D 1.2 – Workshop on demand for space/geospatial education and training
    - D 1.3 – Demand for space/geospatial education and training and priority occupational profiles
    - D 1.4 – Trends and challenges in the space/geospatial sector
- and external studies, analysis and forecasts like:
    - European Commission 'A new Skills Agenda for Europe' (2016)
    - World Economic Forum 'The Future of the Jobs Report (2018)
    - World Economic Forum 'The Future of the Jobs Report (2020)

The mentioned documents provide a broader picture and guidance for the work on curriculum design. They emphasise the necessity of including in modern curricula skills other than technical, also recognizing need to look for complementary forms of education (D1.2). The survey among stakeholders is showing that there is little agreement on which particular skills are linked to which occupation. The results are giving highest importance to Data skills (D1.3) and recognize that geospatial and EO together with Big Data, IoT, IA and Machine Learning, and cloud are technologies that are profoundly changing not only the way of work but the way of life (D1.4). All this has a deep impact on present and even more on future education.

In particular, needs for experts with specific knowledge in the field of EO*GI have been identified. Therefore, it is proposed to create educational offers with the Building Brick approach. In this way, each offer can be adapted to the business offers that exist in the market and fill the current gaps and follow trends and challenges in the space/geospatial sector. This approach is described in detail in section 4.3.

Considering the development of the EO*GI sector and related businesses, its impact on future needs on new occupational profiles becomes visible. Technological revolution, population growth, urbanization, natural and human caused environmental changes, need for sustainability are fostering necessity for, development and growth (as being present and even bigger in future) of EO*GI and related businesses. In parallel, the same technological revolution is bringing automation and robotization of many parts of present and future human working activities resulting in change of the human role in business processes and change of priorities and content in education.

Based on the results of the analysis of the business processes presented in *Chapter 4* of *Deliverable D4.1*, along with conclusions derived from analysing existing academic educational offers in the space/geospatial field (Chapter 2), and education forms and occupational profiles (Chapter 3), the initial structure of education offer based on identified business processes has been drafted. For this purpose, identified and described business processes have been systemized and grouped on the base of several criteria:

- Similarity of the content which they include,
- Volume of the EO*GI content in possible curricula (study),
- Complexity of the content in relation to the educational level,
- Possible discipline to which such education offer could be embedded.

In accordance with the mentioned criteria, the available business processes, and their scope of content, possible educational offers for EO*GI categorization into the following categories was performed:

Mainly EO*GI content in the curriculum (**M**)

The curriculum predominantly involves principles related to Earth Observation and Geoinformation for studying processes in the system Earth and its usage within a system-based approach.

Partially EO*GI content in the curriculum (**P**)

Principles related to Earth Observation and Geoinformatics are associated only to a part of the curricula and are often used for additional classes for students with less background in the domain.

Loosely coupled EO*GI content in the curriculum (**R**)

Principles related to Earth Observation and Geoinformatics are distant in relationship or connection to other topics in the curriculum. The volume of the EO*GI content in possible educational offer is categorized in following categories:

- Course
- Module
- Study.

For the complexity of the EO*GI content in relation to the educational level, existing EQF levels of education are used:

- High school (**EQF 5**),
- Bachelor of Science degree (**EQF 6**),
- Master of Science degree (**EQF 7**),
- Doctoral degree (**EQF 8**) and
- Vocational Education and Training (**EQF 4-7**).

The result of the performed categorization is presented in table 5., while the complete structure linking each business process with identified educational offer is available on EO4GEO Slack (link: https://eo4geo.slack.com/files/U95UERY5B/F01V1HTKTRP/possible_curricula_from_identified_business_processes.docx).

Finally, the educational offer supposed to be developed has to consist of basic elements such as courses covering specific fields, technologies or applications and easily combined in higher level elements like modules and study or training programs.

Relying on the described principles and methodology the following phases in the design of the project EO*GI educational offer have been defined:

- Systematization and grouping of the identified business processes,
- Training of project partners involved in the task on the use of project tools for design of educational offers,
- Design EO*GI educational offers in the CDTool,
- Review of the designed educational offers and
- Finalization of designed project EO*GI educational offers.

Table 5: Overview of systemized educational offer from business processes

Edu offer name	EO*GI content in edu offer	Education level/type (EQF)				
	M, P or R	5 (HS)	6 (BSc)	7 (MSc)	8 (PhD)	4-7 (VET)
Earth Observation and Remote Sensing (EO)	M	Module	Study	Study		
Geoinformatics (GI)	M	Course	Study	Study		
Geospatial Engineering (EO*GI)	M		Study	Study		
EO*GI for Land Monitoring	M			Study		Module
EO*GI for Geospatial Management	M			Study	Module	Module
EO*GI for Natural Risk Management	M			Study	Module	Module
(EO*GI for) Land hazard Monitoring and Management	P			Module		Module
EO*GI for Climate Monitoring	P	Course		Module	Study	Module
EO*GI for Urban Monitoring and Management	P	Course		Study	Module	Module
EO*GI for Hydrology and Hydro-technics	P			Module		Module
EO*GI for Agriculture	P			Module		Module
EO*GI for Transport and Traffics	P			Module		Module
EO*GI for Energy Planning	P			Module		Module
EO*GI for Society	P	Course		Module	Module	
Economical aspects of EO*GI**	R	Course		Module		Module
Legal aspects of EO*GI**	R			Module		Module
EO*GI for Security**	R		Module	Module		Module
Military***						

* The term “Geomatics” has been used in this table as a common nominator for surveying, geodesy, geoinformatics and geomatics being aware that definition of listed terms is not identical and in the context of education does not cover fully identical content. Usage of the term does not imply that this term is the one which we propose to be used further.

** None of the described business processes is particularly focused on economic or legal aspects of EO*GI. However, in both disciplines there are aspects.

*** For completeness, Security and Military have been put in the table. Since there is only one business process applicable under Security, no further elaboration has been made.

3.3.2. Systematization and grouping of identified business processes

The systematization and grouping of identified business processes has been done by the GEOF project team (Task leader) in cooperation with Work package 4 leader PLUS and partners involved in Task 4.2. The carried systematization and grouping of the identified business processes resulted in 16 groups which are presented in table 5. Some of the described business processes have been found appropriate for multiple educational offers being logical due to the inter-disciplinary character of the space/geospatial field.

3.3.3. Training on design of EO*GI educational offer

The training about educational offer design approach and methodology as well as the usage of the Body of Knowledge (BoK) and Curricula Design Tool (CDTool) for EO*GI educational offer design has been organized during the project event organized in Warsaw, Poland as a workshop named 'Design of EO*GI Curricula" on November 27th, 2019. The workshop consisted out of five sessions, lasting 8 hours. The sessions were:

- Session 1: Welcome addresses and introduction of EfVET – European Forum of Technical and Vocational Education & Training
- Session 2: Setting the scene – curriculum design components and approach
- Session 3: Demonstration of BoK related tools
- Session 4: Working session - demonstration and exercise hot to use Living Textbook to explore the BoK
- Session 5: Reports from the working sessions and discussion

The workshop was attended by 47 participants. Workshop minutes (EO4GEO, 2020), presentations and used material are available at the project communication platform (Slack | meeting_05-warsaw | EO4GEO | 3 new items).

The Curriculum Design Tool is one of the EO4GEO BoK-related tools next to the Living Text Book (LTB), Occupational Profile Tool (OPT), Job Offer Tool (JOT), Curriculum Vitae Tool (CVT), Learning Path Tool (LPT), and BoK Matching Tool (BMT). It allows educational providers to create educational offers consisting of modules, courses, and lectures. These are created from scratch, or reusing an existing module, course, or lecture. It shows an interactive graphical and textual view of the educational offer structure. Every level contains different information, such as descriptions, ECTS credits, and it is also possible to link BoK concepts to define associated knowledge, and to use BoK skills as basis for defining learning outcomes. It enables sharing and exporting the offers in different formats.

The modularity of the tool allows to create educational offers at different levels of granularity, from an entire study program to a single lecture or lesson. This enables its utilization by various providers with different focuses, ranging from academia programs to high school curricula or VET trainings. It also enables the re-use of educational offers, by duplicating or promoting existing offers and adapting them to the user's needs. Among others, the tool is populated with a list of innovative educational offers, created by EO4GEO partners, and will be updated with educational offers in the future – e.g., an updated version of the European Skills/Competences and Occupation (ESCO) classification is used for the inclusion of transversal skills. All the details and instructions on Curriculum Design Tool are available at: https://eo4geo-uji.web.app/documentation/CDT.pdf.

With a true hands-on approach in designing the educational offers using CDT that was proposed and conducted during the Task 4.2, several changes were initiated to CDT. Task 4.2 contributed to the modifications regarding the user experience (e.g., resizing of GUI elements, more log-in options,

improved search, better export options, improved BoK relations search) and regarding the accuracy and consistency of the educational offer design (e.g., improved instructions on defining the learning outcomes using the Bloom taxonomy, clarified elements of the educational offer, standardized the steps in designing the educational offer, improved ability to add transversal skills (ESCO) to all levels). All the designed educational offers within the Task contributed also to fulfilling the database of educational offers that were reviewed by the experts in the field, which are a good starting point in designing any new offer in EO*GI field as they can be freely reused and modified as needed.

4. Results

4.1. EO*GI educational offers

For the realisation of Task 4.2 thirteen project partners have been engaged: GEOF (as a Task leader), PLUS (as a Work package leader) and GISIG, KU Leuven, UJI, Patras, Twente, UNIBAS, ROSA, UNEP-GRID, SpaSe, CLIMATE-KIC, IES and initially also ALFA, later replaced by NOVOGIT.

In the preparatory phase partners had the opportunity to choose one or more educational offers identified and systemized in Table 2 and to customize them in accordance with their expertise and developed practices at their institutions. The result of this approach are 42 designed educational offers covering EO*GI related basic knowledge as well as applications. The list of created educational offers, either courses, modules or study programmes covering also different EQF levels is presented in Table 6.

There are:

- 2 Lectures,
- 22 Courses,
- 5 Modules,
- 6 Study programmes,
- 6 VETs

Table 6: EO4GEO designed EO*GI educational offer

Name of designed educational offer	Link	EQF level	Designing partner
Lecture: Introduction to Citizen Science in GI and EO	https://eo4geo-cdt.web.app/detail/N4tKF7JIx5OMczNWGONE	6	KU LEUVEN
Lecture: Reproducibility research in the Geosciences	https://eo4geo-cdt.web.app/detail/dKk3F50eP92glCHSwFS3	8	UJI
Course: Map making toolkit	https://eo4geo-cdt.web.app/detail/JHzTAMUMyZoWWGViYP6J	4	UJI
Course: Air quality in cities - developing emission reduction strategies	https://eo4geo-cdt.web.app/detail/QeLpi5zIiwtbR3w1tVmD	4	UNEP-GRID
Course: Management view on Spatial Data Infrastructures	https://eo4geo-cdt.web.app/detail/1yWQb3glkxtsuDxD6iy5	4	KU LEUVEN
Course: Technical introduction to Spatial Data Infrastructures	https://eo4geo-cdt.web.app/detail/b7vz1XnpNqhNSdywE7Il	4	KU LEUVEN
Course: EO-derived geospatial information for natural hazards management	https://eo4geo-cdt.web.app/detail/bAf6nyb162Yui6M59tRA	4	PLUS

Course: GIS Programming in web environments	https://eo4geo-cdt.web.app/detail/vpp7Chou1gSmrdiU0MOx	5	UJI
Course: Introduction to Programming	https://eo4geo-cdt.web.app/detail/YBTmBvCNBXJnrOGNa3ar	5	UJI
Course: Introduction to Machine learning and Artificial Intelligence	https://eo4geo-cdt.web.app/detail/m0f0Csy0CEpAe3M0gDcQ	6	UJI
Course: GEOBIA Summer School - OBIA Lectures	https://eo4geo-cdt.web.app/detail/D2akSkYfUWQTkYMgrYFS	6	PLUS
Course: Change detection	https://eo4geo-cdt.web.app/detail/lj3bel009aSF0fu4zs3N	6	ROSA
Course: Time Series Analysis of Optical Data	https://eo4geo-cdt.web.app/detail/Gj20qry2wziOTL9cnOgI	6	UNIBAS
Course: Flood mapping using Hydrology Exploitation Platform (H-TEP)	https://eo4geo-cdt.web.app/detail/3jsPswpijVewCa9tDY7E	6	JENA
Course: Geographic data exploration and visualization	https://eo4geo-cdt.web.app/detail/JGo6O9pazF6IdGsyj3AZ	7	UJI
Course: Spatial Data Services, Sources, Standards and Infrastructure	https://eo4geo-cdt.web.app/detail/Kryedy7jNXvXwXahMPCI	7	UJI
Course: Databases and Data Management	https://eo4geo-cdt.web.app/detail/RCsyPr6VlL0AugFIzDmp	7	UJI
Course: Spatial data science	https://eo4geo-cdt.web.app/detail/UAhUCZRXKE1ZjMReXwuN	7	UJI
Course: Geographic Information Systems applications and trends	https://eo4geo-cdt.web.app/detail/atcvxDXgxsJY4Phb5f01	7	UJI
Course: Solar energy forecasting for efficient planning and operation of solar energy farms	https://eo4geo-cdt.web.app/detail/uSV6Alhz1JlHU1CQlp1k	7	UPAT
Course: Geographic Information Systems: Desktop to Web	https://eo4geo-cdt.web.app/detail/wZjszgUQFXmyEzG0TR5r	7	UJI
Course: Persistent / Permanent Scatterer Interferometry	https://eo4geo-cdt.web.app/detail/6N6haxAADaM6VMbikqWy	7	JENA
Course: Geographic data exploration and visualization	https://eo4geo-cdt.web.app/detail/JGo6O9pazF6IdGsyj3AZ	7	UJI
Course: Reproducible research practices for the Geosciences	https://eo4geo-cdt.web.app/detail/pLhQXnqTNfqpcWo0uENr	8	UJI

Module: Multispectral vs Hyperspectral Imaging for Agriculture	https://eo4geo-cdt.web.app/detail/BzUErKApnLXaZxS4SMFP	6	UJI
Module: Legal Aspects of Spatial Data	https://eo4geo-cdt.web.app/detail/rQxcpwGilwDrvcA139yt	6	GEOF
Module: Geospatial technologies	https://eo4geo-cdt.web.app/detail/CjPA7IIPeHPVyK3dn0Q7	7	UJI
Module: Earth Observation for Agriculture	https://eo4geo-cdt.web.app/detail/ji5SWxNgcfgEFZ5Ah3SS	7	GEOF
Module: Data Analytics	https://eo4geo-cdt.web.app/detail/4ONWcJ0b0PHPSL8trZmF	7	UJI
Study Program: Earth Observation of Urban Environment and Climate Change	https://eo4geo-cdt.web.app/detail/Y2M4qfVfa2t2z3DUvfVP	5	GEOF
Study Program: Bachelor Geography - Geoinformatics Modules	https://eo4geo-cdt.web.app/detail/Pv4JMEhgBIZTwZyqZFJd	6	PLUS
Study Program: MoS in Earth Observation Science, Technologies and Applications	https://eo4geo-cdt.web.app/detail/gDrEwUdDwEdxHxT43vnX	7	UNIBAS
Study Program: EO*GI for Land Monitoring	https://eo4geo-cdt.web.app/detail/rhCpltdzbLh4DHeBue3R	7	GEOF
Study Program: Copernicus Master in Digital Earth - GeoDataScience Track	https://eo4geo-cdt.web.app/detail/a0GFWUuWzgfbL86BWogt	7	PLUS
Study Program: MSc on Applied Meteorology & Environmental Physics	https://eo4geo-cdt.web.app/detail/XKluk8hOakUrGV0rBEDL	7	UPAT
Module: VET on Meteorology & Climate Change	https://eo4geo-cdt.web.app/detail/hkkt27xQp646EXUmRQ3x	5	UPAT
Study Program: VET on Climate Change and Land Development and Infrastructure	https://eo4geo-cdt.web.app/detail/S3sR6awYU3ViDLSmOhna	5	GEOF
VET on Earth Observations for Climate Change and Meteorology	https://eo4geo-cdt.web.app/detail/4Z1uaYInYCbhh1Ozn7XK	5	GEOF
Module: VET on Urban Environment and Climate Change	https://eo4geo-cdt.web.app/detail/NDfJwXXesWVsYMJHRBEB	6	PATRAS
Study Program: VET on Advanced Monitoring of Urban Environment and Climate Change	https://eo4geo-cdt.web.app/detail/od80LqrryQTtvsX5dGar	7	GEOF
Module: Legal Aspects of Spatial Data	https://eo4geo-cdt.web.app/detail/QPTbi5KT08S9lTTCM77L	VET	GEOF

4.2. Educational offer review

To ensure the quality of designed educational offer initially created, 34 educational offers have been reviewed by 18 internal and 2 external reviewers. The review was open from end of July till end of September 2020 and included 20 reviewers coming from institutions listed in Table 7.

Table 7: List of institutions educational offer reviewers came from

No.	Partner	No.	Partner
1.	IGIK	11.	TWENTE
2.	GEOF	12.	GEOF
3.	External – Aristotle University of Thessaloniki	13.	External - HAS University of Applied Sciences
4.	NOVOGIT	14.	SPASE
5.	GEOF	15.	GISIG
6.	PLUS	16.	UNIBAS
7.	VRI IES	17.	UPAT
8	PLUS	18.	PLUS
9.	CLIMATE-KIC	19.	GEOF
10.	KULEUVEN	20.	GEOF

The reviewers provided in total 142 reviews, so that out of 35 designed offers, all offers except one had multiple reviews, 4 in average. For the reviewer's questionnaire has been prepared consisting out of 43 questions providing comprehensive information to educational offer designers.

Following the conducted review of the designed educational offer, designers of educational offers have analysed reviews and modified, corrected, improved the designed offers, as well as created eight additional offers, included in Table 8 (Annex). All final educational offers are made open accessible on the EO4GEO web page.

The statistics and analytics of the reviewing process is given in Table 9 (Annex).

4.3 Educational Offer Design: Building Bricks Approach in Action

To demonstrate the *building bricks approach* in action, the following examples present several categories of concepts illustrating the variety of reusable building bricks for the construction of the EO related educational offers. All educational offer items used for the purpose of this demonstration are part of the EO4GEO CDTool inventory and can be accessed through the links provided in Table 6.

We are starting with the example of the *Master of Science Study Programme in EO*GI for Land Monitoring*, illustrated in Figure 6. It is envisaged that this programme would predominantly involve principles related to Earth Observation and Geoinformatics for studying land cover and land use or

variables related to the state of vegetation. Therefore, the programme starts with the one *core module*: *Remote Sensing Fundamentals* build by organising the bricks that teach the basic principles of remote sensing and GIS for studying the processes in the system Earth.

The *domain related*, or so-called specialisation bricks, can be built for deepening the knowledge and skills related to *vegetation monitoring* (in Fig. 6 marked with (1)). The building bricks in the *data analytics module* would teach data and data analytics concepts needed to understand, analyse and interpret data and data sources and make them available using well known standards and infrastructures or to visualize them on a map. In the last brick students work on their *Master thesis*, including a thesis proposal and thesis defence.

Simply by reorganising the bricks in the *domain module*, different specialisations could be offered. For example, specialisation in *water and cryosphere monitoring* (in Fig. 6 marked with (2)), dealing with improved understanding of global climate, hydrologic systems and sea-level change, as well as impact assessments and Earth system modelling. Otherwise, specialisation in *urban remote sensing* (in Fig. 6 marked with (3)) could be offered to teach how to understand dynamic urban processes and climate interventions to help make cities competitive, sustainable and resilient.

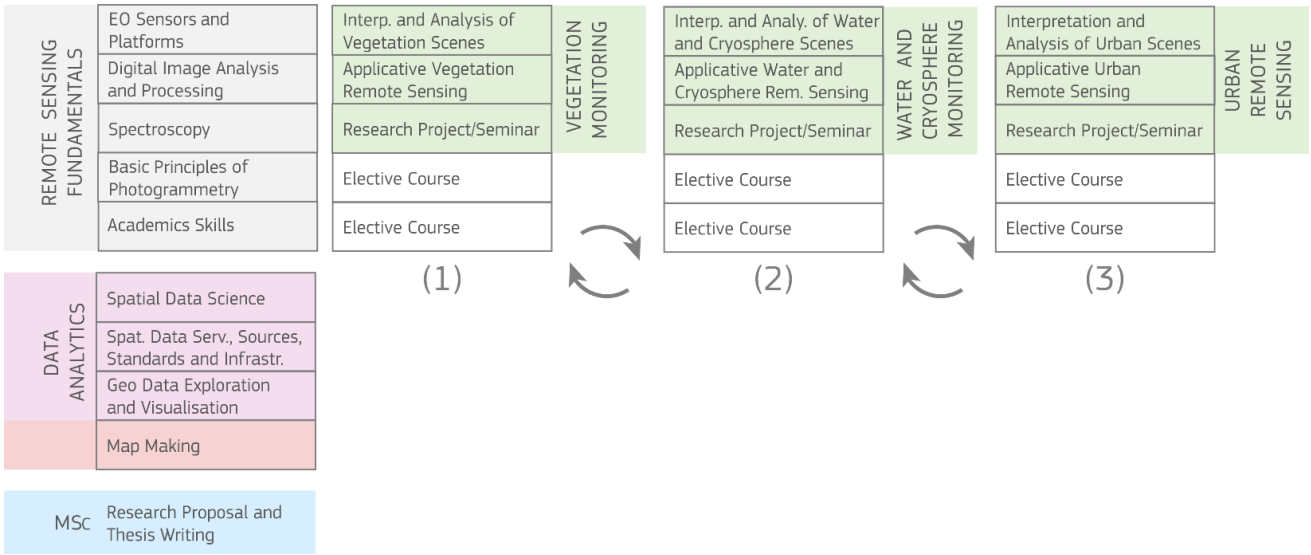

Figure 6. BUILDING BRICKS APPROACH IN ACTION: ACADEMIC MASTER'S PROGRAMME EO*GI FOR LAND MONITORING.
THE DOMAIN RELATED MODULE CAN BE REBUILT WITH DIFFERENT BRICKS FOR DEEPENING THE KNOWLEDGE AND SKILLS RELATED TO VEGETATION MONITORING (1), WATER AND CRYOSPHERE MONITORING (2) OR URBAN REMOTE SENSING (3)

The idea of building bricks strongly relies on the reusability principle, so the next selected example shows how these generically created courses could be recombined in a possible structure of a *Vocational Education Training Programme on Urban Environment and Climate Change*.

The courses *EO Sensors and Platforms*, *Interpretation and Analysis of Urban Scenes, Spatial Data Science* and *Map Making* stored in the CDTool repository that were previously used as building bricks for the Academic Master's Programme EO*GI for Land Monitoring (see Fig. 6) can now be further specified for the concrete case, as illustrated in Fig. 7 marked with (1) and (2).

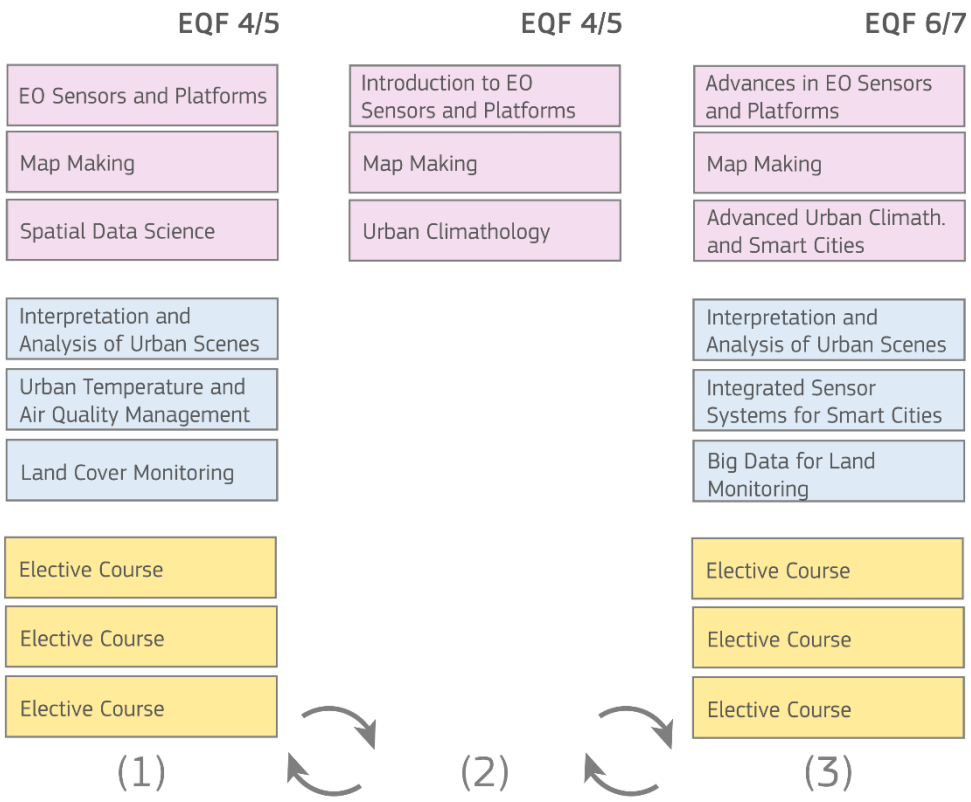

Figure 7. BUILDING BRICKS APPROACH IN ACTION:
VOCATIONAL EDUCATION AND TRAINING PROGRAMME ON URBAN ENVIRONMENT AND CLIMATE CHANGE.
ASSEMBLY, REUSE AND RECOMBINATION OF MODULAR BUILDING BRICKS (1); FURTHER SPECIFICATION FOR THE CONCRETE CASE (2); AND VERTICAL LINKS BETWEEN QUALIFICATIONS (3)

Additionally, by exchanging the *European Qualifications Framework* (EQF) levels defined in terms of learning outcomes, meaning knowledge, skills and autonomy and responsibility, potential vertical links between qualifications are also possible, as illustrated in Fig. 7 marked with (3).

On the other hand, the *Map Making* bricks shown in previous examples could also be quite transversal and introductory for remotely connected study programmes, vocational education trainings or even high schools in which principles related to Earth observation and geoinformatics are quite distant in relationship or connection to curricula.

To conclude, examples presented in this demonstration constitute a brief look at the process of designing an EO related educational offer by assembling, reusing and recombining modular building bricks.

5. Educational offer extension based on delivered trainings

Creating educational offers is a continuous process influenced by numerous internal and external influences. The EO4GEO consortium is aware of this fact and the necessity to develop university courses and modules, as well as vocational and LLL trainings (Task 4.3 Improving existing and developing new training material and T4.4 Development of a mobility programme), which will be delivered to students and professionals and evaluated in frame of Work package 5 and its tasks:

- T5.1 Developing a method for designing case-based scenarios for 3 sub-sectors,
- T5.2 Defining the role of Remote Sensing and related techniques in the scenarios,
- T5.3 Integrated Applications,
- T5.4 Smart Cities,
- T5.5 Climate Change monitoring and adaptation,
- T5.6 Feedback and lessons learned from the testing and validation.

In the frame of Tasks 5.3, 5.4 and 5.5 a large number of courses and training actions have been designed and delivered partially based on educational offer initially developed in Task 4.2 and partly based on external factors. Developed and delivered educational offer grouped in three tasks is presented in the tables bellow.

The nine Integrated Applications courses and trainings covered several application domains: *Agro Monitoring System, Ground Motion, Geo-hazard Zoning, Land Change Detection, Machine Learning and Citizen Science*, showing variety of application fields, see Table 8.

Table 8: educational offer created and delivered in T5.3 Integrated Applications (from T5.3 Report)

Organizer	Learning Scenario	No. of participants	Implementation
UJI	Observing from space agriculture and environment	31	Webinar
Planetek	The rise of Artificial Intelligence for Earth Observation	275	Webinar
PLUS	Optical Earth observation data for landslide risk management	22	Workshop
CNR-IREA	A new Common Agricultural Policy (CAP) based on Copernicus program and EO4GEO tools	80	Webinar
ROSA	Change detection using EO data	10 15	Academic course
GEOF	Fast disaster response – satellite technologies for surface displacement monitoring	77	Webinar
ISPRA	Landslide affecting Cultural Heritage sites - Roman Thermae of Baia	11	OOC
KU-Leuven	Development of a citizen science project within the MyGardenLab environment	5	Webinar and Project work
IGEA	Data-driven platform for efficient farm management combining EO, IoT and GIS data	45	Webinar

The 5 Smart Cities courses and trainings covered three application domains: Urban (green) Planning, city Sustainability to Natural Hazards and Urban (heat islands) Planning which all are relevant for development of Smart Cities, see Table 9.

Table 9: Educational offer created and delivered in T5.4 Smart Cities (from T5.4 Report)

Organizer	Learning Scenario	No. of participants	Implementation
GIB, EPSIT, GISIG	Identification of local heat islands to support city planning	82	Webinar
GIB	Evaluation and planning of urban green structures	21 14	Webinar
GIB	Smart cities, UHI and urban green (preparing for workshop), Swedish	10	Webinar
GIB	Smart cities, UHI and urban green (WS with a technical focus and more hands-on work), Swedish	8	Workshop
GIB	Improving sustainability of cities to storm and water	1	Project work

The 8 Climate Change monitoring and adaptation courses and trainings covered several application domains: Air Quality, Climate Change, Fire Detection, Solar Potential, Urban Greenery Management and Early Warning for Disease Epidemics, see Table 10.

Table 10: educational offer created and delivered in T5.5 Climate Change monitoring and adaptation (from T5.5 Report)

Organizer	Learning Scenario	No. of participants	Implementation
UNEP-GRID	EO for urban greenery management	54	Webinar
UPAT	Air quality monitoring and management	156	Webinar
PLUS	Early warning for disease epidemics at regional level	122	Webinar
EIT CLIMATE-KIC	Spark! - Earth observation and geographic Information: a crucial tool to monitor and tackle climate change	80	Workshop
SERCO	Active fire detection with Sentinel-3	39	Webinar
UPAT	Solar potential maps at municipal level	~200	Webinar
NOVOGIT	CO_2 budgets for municipalities	13	Open Online Course (OOC)
UPAT	Air Quality Monitoring and Management – advanced	46	Workshop

Developed and delivered courses and trainings are creating dynamical changes of the educational offer, showing that the number of developed courses and training increased by 50%. From the initial 41 course and training created in the frame of Task 4.2 an additional 22 courses and trainings have

been designed increasing the EO4GEO educational offer to 63 courses and trainings. Details about additionally developed courses and trainings can be found in T5.3, T5.4 and T5.5 reports.

Upon the analysing the overall project educational offer regarding different types of education it became obvious that 60% of the created educational offers are designed for academic - initial vocational education and 40% for continuing vocational education (professional training), see Table 11. However, one should be aware that academic educational offer can easily be modified towards vocational education.

Table 11: Project educational offer per types of education

Educational offer	Type of offer	No of offers
Created for initial vocational education - academic education	Study programme	7
	Module	6
	Course	23
	Lecture	2
Created for continuing vocational education (professional training).	Study programme	2
	Module	3
	Course	18
	Project work	2
	Σ:	63

Further analysis of the overall project vocational education offer regarding which forms of work-based learning has been integrated in the designed curricula/programmes/modules, hardly allows exact quantification. Considering initial vocational - academic education all study programmes and modules (13 offers) understand also one of the forms of work-based learning (WBL), either apprenticeship, informal apprenticeships, traineeships or internships, what depends predominantly on internal organization of the educational institution. When speaking about academic institutions, which are dominant in the EO4GEO consortium, then traineeships or internships can be understood as dominant forms of WBL. In the context of traineeships or internships work placements abroad are integral, but not an obligatory part of the curricula/programmes/modules for most of academic institutions.

Considering project offered continuing vocational education (professional training) curricula/ programmes/modules 2 offers (Project work) are directly linked to WBL, while further 5 (study programmes/Modules) offer possibility to implement one of the WBL forms.

In project application special attention has been given to combining classical university education and structured work experience - work placements. Defined in T4.4 Development of a mobility programme this activity suffered from Covid-19 pandemic, but still it has been conducted, with 13 mobilities organized, also thanks to the adoption of a blended or virtual mobility schemas, plus additional 11 already scheduled. It is also worthy to mention that 22 companies offered or are still offering internships opportunities, confirming the relevance of work placements, but recognizing at the same time challenges in executing of such form of education.

6. Summary and Outlook

This report summarizes the activities of the EO4GEO project in providing an approach and methodology in designing EO*GI curricula based on EO4GEO developed tools formulating a set of educational offers (lecture, courses, modules, and study curricula) aiming to support education modernization in the EO*GI domain. Previous analysis and synthesis have shown that the EO*GI nexus is interconnected with many aspects of human society with a clear trend on grow.

In accordance with the described methodology and processes, educational offers consisting of 42 units were designed, covering a variety of themes organized in lectures, courses, modules, curricula and foreseen for different levels and educational forms: academic and VET programs, summer schools, trainings, etc. Some of those units are part of the training action in WP5 prepared by the project partners and planned to be delivered in the last year of the project lifetime.

The designed educational offers present a crosscut of curricula in a moment of time aspiring fast technological and societal developments. The offer should be continuously updated and further developed. Envisaging trends and incorporating them into future education (courses, study programmes) was and is a challenge for educational institutions.

In the mentioned context, analysing the results of the overall process of designing of the EO4GEO project EO*GI educational offer allows the following conclusions:

- For the purpose of designing the EO*GI educational offer in the frame of EO4GEO project, the present Academic Master's programmes in Geo-Information science and Earth Observation have been analysed, resulting in observed structures as presented in Figure 5 which can be recommended when designing new programmes or updating existing ones.
- The designed EO*GI educational offer represents a good reference platform for any interested actor which considers designing EO*GI and related educational offer.
- The "building bricks" approach enables interested actors to use EO4GEO offers and creates an own educational content with reduced efforts.
- Nevertheless, the fast development of the EO*GI and related technologies, as well as the need to envisage future needs of society in designed educational offer, are imposing the necessity to recursively consider a redesign of the educational offers and enrich it with recent developments and trends.
- It should be emphasized that the educational offers have so far only been a subject of internal review only. The usability of the approach has yet to be verified, including testing by external stakeholders.

Finally, the initial project educational offer (41 unit) has been extended by 22 additional units created by WP5, creating good balance (60/40 %) between initial vocational – academic - and continuing vocational education and covering great variety of application domains.

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URI2: ISCO-08 Index of occupational titles, https://www.ilo.org/public/english/bureau/stat/isco/isco88/major.htm.

URI3: BLS, Standard Occupational Classification, https://www.bls.gov/soc/.

URI4: Remote Sensing Specialist Career, https://www.mymajors.com/career/remote-sensing-specialist/.

8. Annex: Educational offer review statistics and analytics

In Table 8 the statistics of conducted reviews is presented followed with the analytics of the review findings.

Table 8: Statistic of conducted reviews

Name of reviewed educational offer	Number of reviews
Module: Geospatial technologies	1
Module: Multispectral vs Hyperspectral Imaging for Agriculture	2
Course: GEOBIA Summer School - OBIA Lectures	2
Study Program: MoS in Earth Observation Science, Technologies and Applications	3
Module: VET on Meteorology & Climate Change	3
Course: Change detection	3
Course: Geographic data exploration and visualization	8
Course: Map making toolkit	3
Module: Earth Observation for Agriculture	4
Course: Preparation of CO2 budgets and solar potential maps at municipal level	3
Course: Spatial Data Services, Sources, Standards and Infrastructure	8
Course: Introduction to Machine learning and Artificial Intelligence	6
Study Program: VET on Advanced Monitoring of Urban Environment and Climate Change	4
Course: Reproducible research practices for the Geosciences	3
Study Program: Bachelor Geography - Geoinformatics Modules	4
Course: Air quality in cities - developing emission reduction strategies	6
Course: Databases and Data Management	8
Study Program: EO*GI for Land Monitoring	3

Module: Legal Aspects of Spatial Data	3
Module: Legal Aspects of Spatial Data	2
Study Program: VET on Climate Change and Land Development and Infrastructure	4
Course: Spatial data science	8
Course: Management view on Spatial Data Infrastructures	3
VET on Earth Observations for Climate Change and Meteorology	6
Study Program: Copernicus Master in Digital Earth - GeoDataScience Track	4
Course: Geographic Information Systems applications and trends	7
Course: Technical introduction to Spatial Data Infrastructures	3
Course: EO-derived geospatial information for natural hazards management	2
Course: Solar energy forecasting for efficient planning and operation of solar energy farms	3
Course: GIS Programming in web environments	2
Course: Geographic Information Systems: Desktop to Web	7
Study Program: MSc on Applied Meteorology & Environmental Physics	3
Study Program: Earth Observation of Urban Environment and Climate Change	3
Course: Introduction to Programming	8

Analytics of reviewer's findings

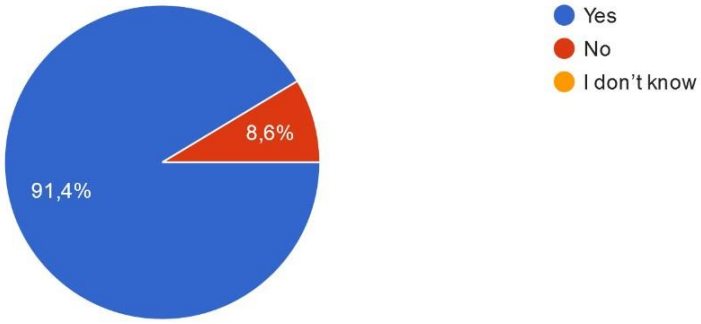
Part 1: Completeness of educational offer.

Table 9: Does respective educational offer contain input information in requested CDTool field?

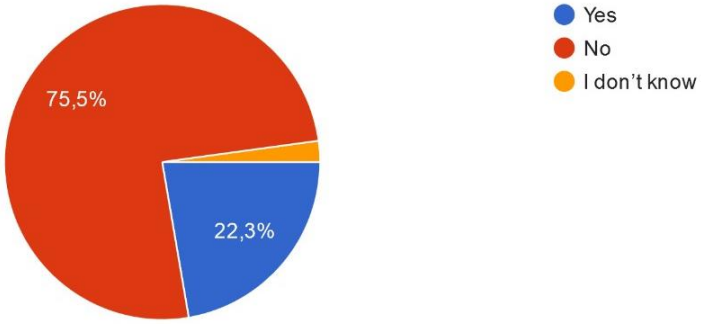
Question	Yes	No
Organization (Is the educational offer item saved under organization EO4GEO?)	130	9
Affiliation	121	18
EQF	134	5
Study area	134	5
ECTS	115	24
Title	138	1
Description	128	11
Assessment	101	38
Prerequisites (even if "None" is loaded)	27	112
Inherited learning outcome	74	65
Learning outcomes	126	13
Linked BOK concepts	134	5
Transversal skills	130	9
Child educational offer	123	16

Part 2: Analytics of reviewer's findings

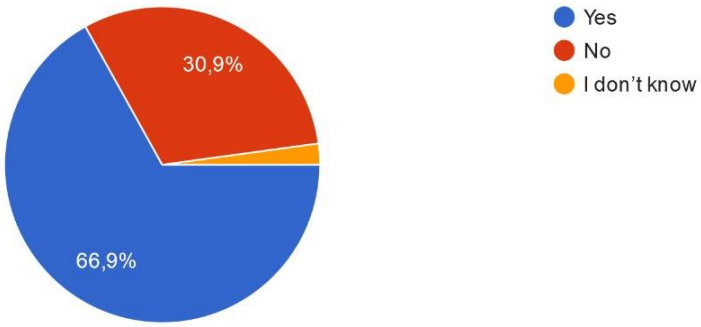
Is the educational offer title clearly understandable?



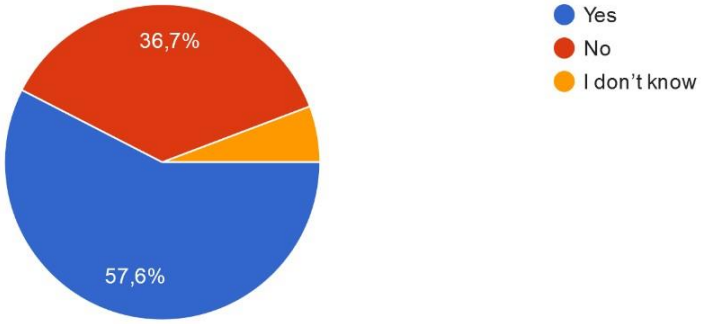
Do you find educational offer title should/could be modified?



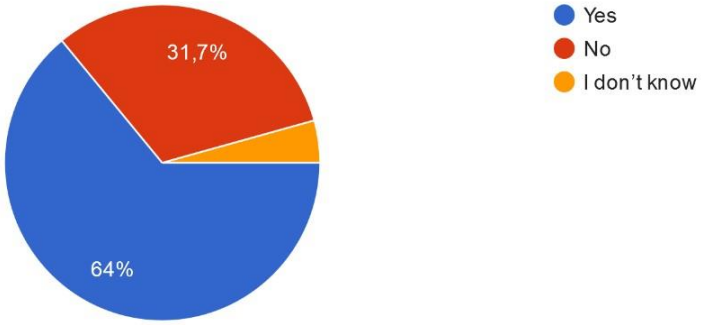
Do you find defined learning objectives clearly understandable?



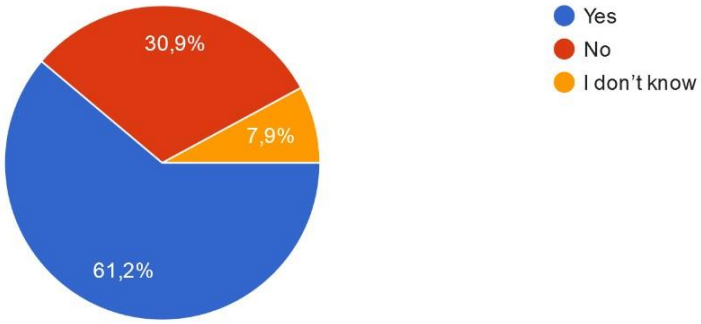
Do you find defined learning objectives well-tuned with educational offer description and outcomes?



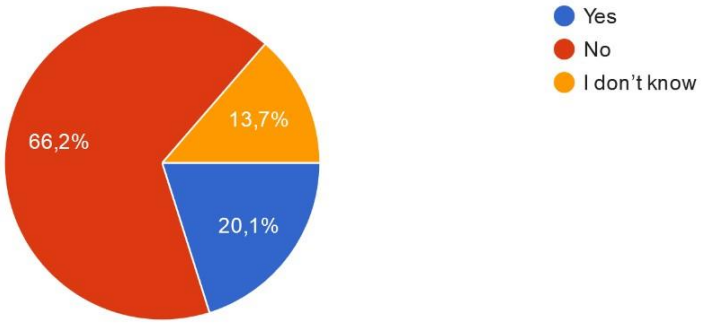
Do you find defined learning objectives appropriate?



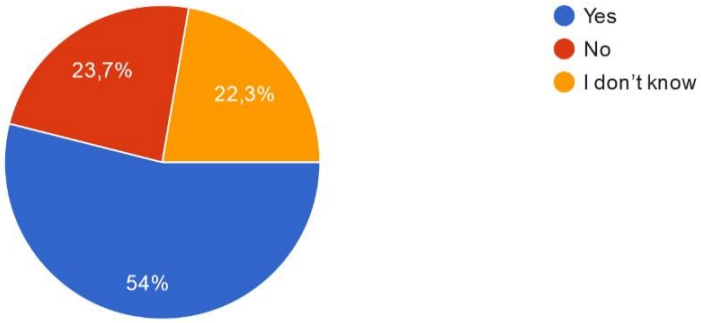
Do you find defined learning objectives feasible?



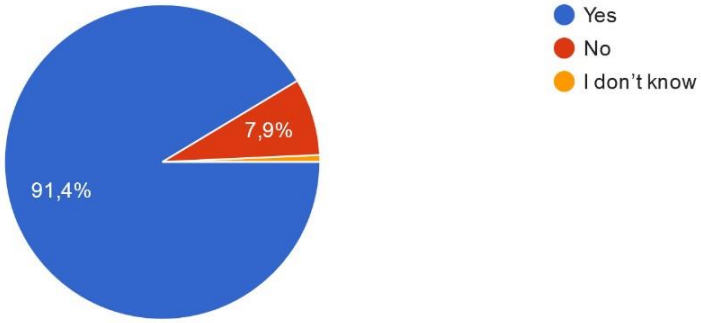
Do you find prerequisites are well defined (even if designer put none) for educational offer?



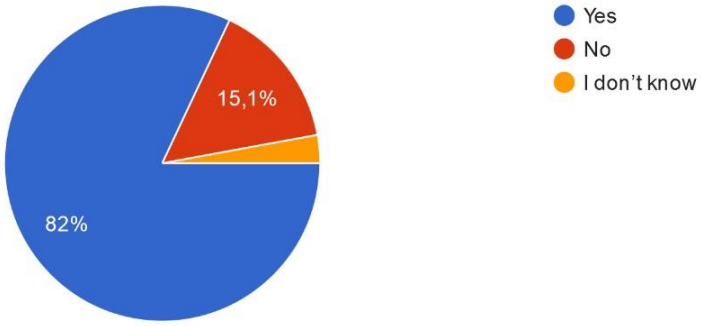
Do you find number of assigned ECTS is appropriate?



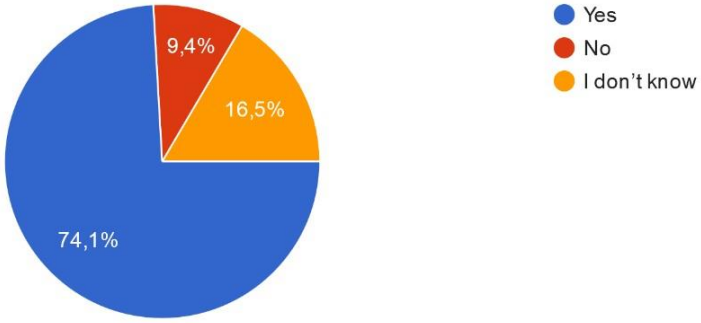
Do you find defined outcomes clearly understandable?



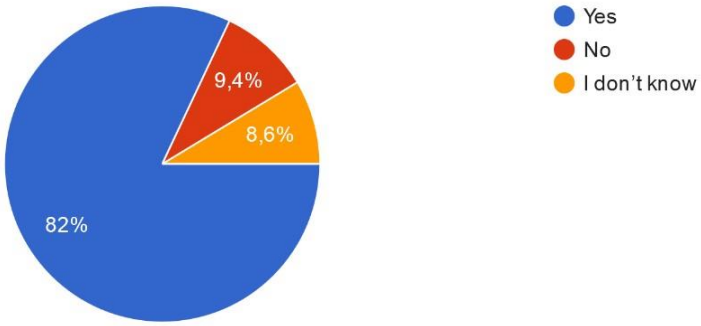
Do you find defined outcomes appropriate?



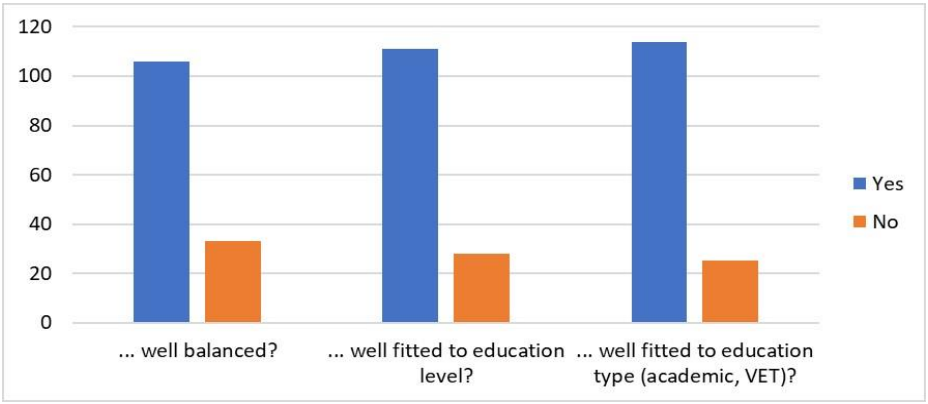
Do you find defined outcomes fitting Blooms taxonomy?



Do you find defined outcomes appropriate to the educational level?



Do you find that theoretical and practical part of educational offer...?



Do you find that knowledge and skills part of educational offer ...?