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DIS4SME

WP 2 “Knowledge base, methodology and tools”

Deliverable No. 2.1 : Trends and challenges on location data interoperability education and training

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List of Acronyms

AI	Artificial Intelligence
API	Application Programming Interface
CSW	Catalogue Service for the Web
DT	Digital Transformation
EIF	European Interoperability Framework
EIRA	European Interoperability Reference Architecture
EU	European Union
GI	Geographic Information
GIS	Geographic Information System
ICT	Information and Communication Technologies
MOOC	Massive Open Online Course
OGC	Open Geospatial Consortium
RDF	Resource Description Framework
SDI	Spatial Data Infrastructure
SME	Small and medium-sized enterprises
URI	Uniform Resource Identifier
WFS	Web Feature Service
WMS	Web Map Service
WMTS	Web Map Tile Service
WPS	Web Processing Service

Executive Summary

In this report the results and key findings are presented of the DIS4SME study on the current offer of training on location data interoperability and related topics. The study relies on a mapping and in-depth analysis of existing training courses in Europe dealing with location data interoperability. The main aim of this study was to gain insight into what training courses currently exist on location data interoperability, what topics are addressed in these courses and which teaching methods, materials and good practices could inspire and support the design and development of new training in the context of DIS4SME.

As such, the study and its results provide a comprehensive overview of existing training courses dealing with location data interoperability and related topics. In total 98 relevant courses were identified and further investigated, looking first at general characteristics such as the language, the platforms through which they are provided, the targeted trainees and the approaches used for the assessment and certification of trainees, and afterwards at the content and learning objectives.. For both the discovery, collection and analysis of these courses, the study relied on a combination of manual and (semi-)automated methods, in which all DIS4SME partners were engaged. The study took into consideration various studies and initiatives on mapping, promoting and/or offering training on data interoperability in Europe. The DIS4SME partners especially contributed to the identification of other relevant courses at the national or European level.

The training courses that were included in the analysis consisted of two main categories of training: while there are several courses dealing with GI, GIS and especially SDIs (and topics related to these), there's also a big group of courses focusing on (open) data and (digital) technology in general. For the future design and development of the DIS4SME courses, it can be argued that it is important to take into consideration both groups of courses, when dealing with a particular topic.

A key result of this study is the identification of the core concepts in the existing offer of training. Twenty core topics that are central in the existing offer of training on location data interoperability were identified and further investigated. For each of these concepts, we identified the main courses in which the topic is covered, the learning objectives associated to the concept and a set of related topics that often are addressed in the same set of courses. Through a clustering of related concepts and courses we identified seven core clusters of topics: Spatial Data Infrastructures, Legal/Governance, Interoperability, Standards, Data sharing and access, Digital transformation and Knowledge representation.

In combination with the DIS4SME analysis on the current demand for training on location data interoperability, and the assessment of the skills gaps and mismatches between the offer of training and the demand for skills, this study will serve as important input to the definition of the DIS4SME curriculum, the co-creation of training materials and the delivery of DIS4SME training courses, which will cover skills and knowledge areas that are insufficiently addressed in the existing offer.

1. Introduction

1.1. Purpose and audience of the document

The main aim of DIS4SME is to provide SMEs with the right skills required to orient their Digital Transformation (DT) strategies and plans around data interoperability, and location data interoperability in particular, as enabler of all the key capacity areas addressed by the Digital Europe Programme. This will be done through the design, development and implementation of several types of training courses targeted to SMEs.

To make sure the training courses that will be designed and offered by DIS4SME fully address the skills needs and skills gaps on (location) data interoperability, an in-depth analysis is made of both the current offer of training and the demand for training on data interoperability in different fields. This deliverable reports on the methodology, results and findings of the analysis of the current state and trends in education and training for ICT SMEs. The report provides an overview and assessment of the current supply of training on location data interoperability and related topics in Europe.

1.2. Relation to other activities

This report focuses on one side of the skills gaps and skills needs assessment on location data interoperability, i.e. the supply side. In combination with the identification and assessment of the demand for skills on location data interoperability, which is done as part of task 2.2 of the DIS4SME project, it will allow an analysis of the skills shortages, gaps and mismatches between the offer of training on one hand and the demand for training and skills on the other hand.

This analysis of skills shortages, gaps and mismatches will serve as important input to the definition of the DIS4SME curriculum, the co-creation of training materials and the delivery of training courses, which will cover skills and knowledge areas that are not or insufficiently addressed in the existing offer. At the same time, the analysis of the current offer will allow to build up or even reuse existing training resources, and learn from good practices in designing, offering and assessing training and learning on location data interoperability.

1.3. Structure of the document

This report is structured as follows. After this introductory chapter, the second chapter briefly discusses the methodology of the study on the current offer of location data interoperability training in Europe. This chapter sets out the objectives and scope of the study and discusses the methods

for discovering, collecting and analysing the data. The third chapter looks into the general characteristics of the courses, such as the platforms and providers offering the courses, the target audience, the language in which they are offered, the training methods and materials and the possible certification of participants. Chapter four focuses on the content of the training courses, by identifying the core concepts in the course names, course content and learning objectives. In chapter five these core concepts are further explored, and insight is provided into the courses and learning objectives related to each concept. In chapter six, a cluster analysis is presented, in which relationships between concepts are used to identify clusters of courses, covering similar and/or related concepts. The seventh and final chapter of the report provides the conclusions on the current status and trends in training on (location) data interoperability.

2. Methodology

This chapter discusses the methodology of the study on the current offer of training on location data interoperability. After setting out the objectives and scope of the study it presents the approach and methods for discovering, collecting and analysing data on existing training courses in the domain of location data interoperability.

2.1. Objectives

The main aim of the study presented in this report is to analyse the current state of the supply of vocational education and training in Europe regarding location data interoperability. The study builds on previous initiatives and studies on investigating the supply of education and training in the domains of GI and GIS.

More specific objectives of the study are:

- To provide an overview of the current landscape of training on location data interoperability and related topics;
- To identify the core topics and skills addressed in the existing training on (location) data interoperability;
- To collect relevant training resources, materials and good practices that could be used for the design, development and delivery of training on location data interoperability in the context of DIS4SME.

2.2. Scope of the study

The scope of the study originally was defined as follows:

- The focus of the study was on training (courses) dealing with or related to **data interoperability, and location data interoperability** in particular;
- As per the European Interoperability Framework, there were **several interoperability layers** that were considered as relevant:

- **Semantic interoperability** ensures that the precise format and meaning of exchanged data and information is preserved and understood throughout exchanges between parties, in other words 'what is sent is what is understood'[1].

- **Technical interoperability** covers the applications and infrastructures linking systems and services. Aspects of technical interoperability include interface specifications, interconnection services, data integration services, data presentation and exchange, and secure communication protocols[2].

- **Legal interoperability** is about ensuring that organizations operating under different legal frameworks, policies and strategies are able to work together[3].

- **Organisational interoperability** refers to the way in which public administrations align their business processes, responsibilities and expectations to achieve commonly agreed and mutually beneficial goals[4].

- The study also takes into consideration training (courses) on **new and emerging technologies that are related to and/or might have an impact on interoperability issues.** Examples of such technologies and developments big data and data analytics; artificial intelligence; blockchain and distributed ledger technologies; Internet of Things including, sensor web enablement and event stream processing; the cloud, the fog and the edge; API's as the new way to expose data; Digital Twins, extended and augmented reality; etc.

- Although the main focus of DIS4SME is on training for businesses and SMEs in particular, in our analysis of the current state of the supply of vocational education and training we also want to take into consideration **trainings targeting other organizations and persons,** such as public authorities, research institutions, etc or trainings with a broader target audience. This could especially support the identification of relevant training materials.

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[1] NIFO Glossary - Semantic Interoperability: https://joinup.ec.europa.eu/collection/nifo-national-interoperability-framework-observatory/glossary/term/semantic-interoperability

[2] NIFO Glossary – Technical Interoperability: https://joinup.ec.europa.eu/collection/nifo-national-interoperability-framework-observatory/glossary/term/technical-interoperability

[3] NIFO Glossary – Legal Interoperability: https://joinup.ec.europa.eu/collection/nifo-national-interoperability-framework-observatory/glossary/term/legal-interoperability

[4] NIFO Glossary – Organisational Interoperability: https://joinup.ec.europa.eu/collection/nifo-national-interoperability-framework-observatory/glossary/term/organisational-interoperability

- With regard to the geographic scope, we do not limit our analysis to training provided in the participating countries (BE, ES, HR, IT, SI), but also take into consideration courses provided in other countries and/or at the European level.

- It was decided to fully focus on (vocational) training courses, and not on academic courses offered in the context of programmes leading to the award of an academic degree. Such training courses can be provided by higher education institutions but also by other types of training providers. The focus on (vocational) training allows us to especially take into consideration courses in which learning takes place with a goal of performing a specific skill or behaviour.

2.3. Discovery of courses

For the discovery of relevant courses a three-stage approach was followed. A first set of relevant courses, course providers and course platforms were identified by the study team through desk research. This desk research looked into the results and findings of previous studies on the offer of training on GI and geospatial data. The desk research also investigated into well-known initiatives and platforms dealing with digital skills, (geospatial) data and data interoperability.

In the second stage, all DIS4SME project partners were invited to provide input to the study, and to the identification of relevant courses in particular. Partners were asked to provide input to three questions:

1. What are relevant specific courses (our course modules) to take into consideration in the analysis?

2. What are relevant training providers and/or training platforms to take into consideration in the analysis?

3. What keywords would you suggest to use for the manual/automatic search of relevant courses?

In the third stage, the answers provided to these questions were used to discover and collect additional courses. The keywords suggested by the DIS4SME partners were used to search for courses via web crawling techniques. In total, 98 relevant courses were identified and verified as courses meeting the requirements to be considered as courses related to location data interoperability. The applied data discovery approach, combining manual and automated methods, resulted in a comprehensive and up-to-date inventory of – location - data interoperability training in

Europe. Therefore, the analysis of these courses will provide insight into key trends and challenges on location data interoperability education and training in Europe.

2.4. Data collection

Prior to actually collecting the data on the courses, an investigation was made of the information provided on the courses through the online course descriptions. Although there were some common elements in most of the online descriptions, the information provided in the courses was different across course providers and course platforms.

To illustrate this, table 1 shows the information elements of the course descriptions on different relevant platforms.

Table 1 Information elements in the course descriptions

Course platform	Course information
Location Innovation Academy https://academy.ogc.org/	Description - Target group - Learning objectives - Structure
EU Academy https://academy.europa.eu/	Course Details - Target audience - Learning Objectives - Provider - Schedule
EUHubs4Data Training Catalogue https://euhubs4data.eu/courses/	Topics & sub-topics - Language - Duration - Trainer - Keywords - Learning outcomes - Target audience - Course Type - Materials
EO4GEO Training Material Catalogue http://www.eo4geo.eu/training-material-catalogue/	Type of resource - Description - Learning Outcomes - Topics - Ownership - Education Level - Language

Since the data used for the analysis had to be harmonized but also as complete as possible, data were collected on course characteristics for which information was available in most course descriptions.

Information on the following characteristics was included in the data collection:

1. Course name

2. Target group
3. Country
4. Platform/ Provider(s)
5. Language(s)
6. Course content
7. Learning objectives
8. Course methods
9. Link to online course description

2.5. Data analysis

The data analysis focused on both the general characteristics of the courses and the content of the courses.

With regard to the general characteristics, an investigation was made of the platforms and providers offering the courses, the target audience, the language in which they are offered, the training methods and materials and the certification of participants who completed the training. The results of this investigation are presented in chapter 3.

In addition to this, an in-depth investigation was made of the content of the courses, by identifying and analysing the core concepts in the course descriptions. With regard to this analysis of the course content, three types of analyses are made. First, the core concepts in the course descriptions were identified through word clouds and word counts, which are presented and discussed in chapter four of this report. Afterwards, these core concepts were further investigated, and for each concept an overview was made of the courses in which the concept was addressed, the main other concepts related to the concept and the learning objectives associated with the concept. This in-depth investigation of the core concepts is presented in chapter five. Finally, we identified clusters of related courses and concepts, and further investigated the relationships between concepts. This cluster analysis and associated network analysis are discussed in chapter six.

3. Course characteristics

This chapter looks into some general characteristics of the training courses, such as the platforms and providers offering the courses, the target audience, the language in which they are offered, the training methods and materials and the certification of participants who completed the training.

3.1. Platforms and providers

In total 98 different training courses on (location) data interoperability were included in the analysis. Table 2 shows the main platforms and providers of these courses. A large part of the courses identified are provided via five main platforms: the Geospatial Knowledge Base (GKB) Training Platform (18%), data.europe.eu (16%), the Location Innovation Academy (15%), the online training platform of Z_GIS of University of Salzburg (14%) and the EU Academy (6%). The remaining courses are offered at platforms and via other providers.

Table 2 Training course platforms and providers

Course platform	Number of courses
Geospatial Knowledge Base (GKB) Training Platform	18
Data.europe.eu	16
Location Innovation Academy	15
Z_GIS (University of Salzburg)	14
EU Academy	6
Other	29

The **Geospatial Knowledge Base (GKB) Training Platform** (https://www.geo-train.eu/) hosts a set of training modules in the context of the European Location Interoperability Solutions for E-Government (ELISE) project, addressing Geospatial and location services in eGovernment, based on the INSPIRE Directive. The platform is hosted and maintained by GISIG, a sectoral non-profit

Association on Geographical Information Systems (GIS), and is part of the official INSPIRE Knowledge Base Training Library. Eighteen courses of the platform (so-called modules) are included in the analysis, as they are dealing with (location) data interoperability and related topics. These modules are organized in three main categories: Context knowledge for INSPIRE, Advanced technical modules and Technological trends and innovative solutions. In December 2020, four new and updated modules were added to the platform: 'From INSPIRE to e-Government', 'Monitoring and understanding emerging geospatial technologies', 'Principles for Data and Metadata Harmonisation according to INSPIRE' and an update of the module 'INSPIRE Network Services'.

The **data.europa academy** (https://data.europa.eu/en/academy) is an e-learning programme to enable learners to discover what open data is and how it is changing the lives of everyone on the planet. It is part of the official portal for European data, which is the central point of access to European open data from international, European Union, national, regional, local and geodata portals. Sixteen different courses from data.europe are included in the analysis. These courses cover a broad set of topics related to (open) data, such as an introduction to open data, the legal aspects of open data, the integration of open data into applications, measuring the impact of open data, data visualization and communication, data governance and data spaces.

Location Innovation Academy (https://academy.ogc.org/) is a free online training program based on the knowledge and ideas generated by the European GeoE3 project. The aim of Location Innovation Academy, which is hosted by the Open Geospatial Consortium, is to help government agencies, and national mapping organizations in particular, to make the most of their existing geospatial platforms and create an ecosystem of generic services that can connect various datasets and services with geospatial data. The online training package includes three different courses, from which learners can choose various modules to develop their skills. The content of the modules was produced by an international team of experts in the domain of geospatial data. In the analysis, fifteen different modules are included as separate courses. These modules cover three categories of topics: Data Management, addressing topics such as licenses, metadata, semantic enrichment, semantic and organisational interoperability and data quality, Service Management, with topics such as data access standards and other API standards, and Data and Service Integration, covering topics such as joining spatial and statistical data, the integration of meteorological data and applications for OGC APIs.

The Interfaculty Department of Geoinformatics Z_GIS of the **University of Salzburg** (https://geoinformatik.at/course/index.php) makes available various online training resources through its Moodle-based training platform. Many of these online courses and materials are the output of past and ongoing education and capacity building initiatives (e.g. education programmes, education and training projects, etc.). Several of the online courses offered via this platform are related to location data and interoperability. In our analysis, we especially took into consideration

several courses on Spatial Representations and Spatial Data Infrastructures, addressing topics such as metadata and catalogues, geoportals, standards, services, sensor web and other related topics.

The **EU Academy** (https://academy.europa.eu/) is an EU-owned online hub containing educational resources and insights, directly produced by the EU institutions, for individuals whose work is related to its sphere of action. The mission of the EU Academy is to provide a modern and engaging learning environment that can foster and improve the quality of the application of knowledge on EU-matters in a simple, smart and inspirational way. The aim is to facilitate a good understanding and successful implementation of EU policies in a wide array of fields. The platform contains several resources on data, digital and technology, which are dealing with EU policies, initiatives and programmes on exploiting the opportunities of data and technology. Six courses made available on the platform are related to data interoperability and were included in the analysis. These courses deal with topics such as interoperability, the European Interoperability Framework (EIF) and the European Interoperability Reference Architecture (EIRA) and innovative public services.

Also several other platforms and providers offered multiple courses on (location) data interoperability and related topics. The **Agency for Digital Italy** offers several resources on 'Open Data from theory to practice', in which aspects such as data quality and validation, data publication and re-use, and data modelling and enrichment are covered. **GIM**, a Belgian SME specialized in geo-information, has a broader offer of GI-related trainings, including several topics dealing with interoperability issues. Courses on data interoperability topics are also offered through platforms covering a wide variety of courses, such as Class Central, FutureLearn and OpenHPI. The EU Digital Skills & Jobs platform also provides links to courses on these topics from various training providers.

3.2. Target groups

For most of the courses included in the analysis, the online course descriptions provide some information of the target audience or target group(s) of the training. It can be noticed that in many cases the provided information remains quite general, and many courses target a broad variety of possible participants or trainees.

Overall, the information provided can cover different aspects:

- **Sector:** public sector, private sector, academia, non-government organizations, journalisms
- **The role or profession of the trainee:** policy makers, managers, academics students, system architects, public service designers, public service providers, application developers, data users, data publishers, data producers, etc.
- **The knowledge/skills level**: beginners versus experienced professionals or experts

Looking at the proposed target groups in the existing courses on data interoperability, two main recommendations can be drawn. First, there clearly is a need for training for SMEs and their staff members, as many of the existing courses seem to target the public sector, and public sector managers, public servants and data providers in particular. Second, it is important to think well about the precise target group of the trainings, as the knowledge and skills needed will be different between various target groups. Therefore, it can be recommended to clearly identify and describe the targeted trainees in terms of their sector, role or profession and knowledge level. In case the training focuses on a particular domain or area – e.g. construction, environmental management, transport, etc. – also this should be clearly indicated in the target audience.

3.3. Language & training materials

With regard to the language(s) in which the training is provided, most of the courses included in the analysis are targeting trainees across Europe, and are provided in English. As shown in table 3, there are some courses provided in another language, while some courses are provided in multiple languages. For future studies, this demonstrates the need to consider new methods and approaches for discovering courses provided in national languages.

Table 3 Language of the course

Language	Number of courses
English	84
Other	8
Multiple	6

Important to mention also is that the majority of the trainings we've identified are online courses. This, to a certain extent, could be attributed to our data discovery and collection approach, which focused on online course descriptions. While there also is a need to look for more effective methods and approaches for identifying in person training courses, the added value of the online training modules, of which the majority are open to everyone, is that the materials easily can be accessed, and in some cases also re-used. While some courses provided information on the licenses applicable to the material, for most courses this information seems to be not available.

3.4. Assessment and certification

Another aspect we've investigated in our study is the assessment of participants, and the awarding of a certificate in case of successful completion of the course. Several of the courses include the awarding of some kind of certificate. This is done under various stipulations, depending on the platforms or organizations offering the courses. Some of these stipulations include:

- Completion of all sections of the course.
- Completion of at least a given percentage of the course.
- Payment for use of the platform which makes the certificates available, like Coursera
- Graded courses with a passing score.

Assessment of the learners is however not included in most of the courses. A requirement to mark a section as complete before moving to the next is available for a few courses, as well as the possibility to do the course in any order to completion. These different aspects can be taken into consideration for the assessment and certification of learners participating in the DIS4SME courses

4. Content of the training courses

This chapter examines the content of the existing training courses on (location) data interoperability in Europe. Through word clouds and word counts the core concepts are identified in the course names, course content and learning objectives.

4.1. Course names

Figure 1 shows the word cloud of concepts in the course names. It immediately shows the importance of concepts such as spatial representation, spatial infrastructure, semantic(s), interoperability, web, standards etc.

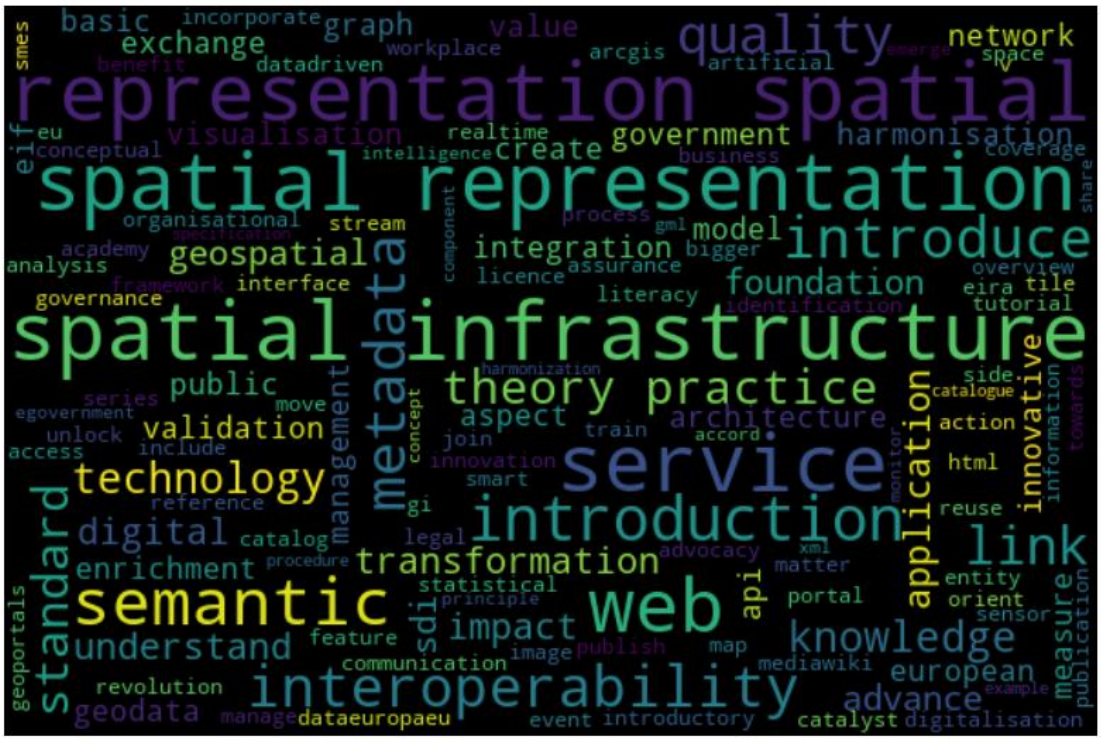

Figure 1 Word cloud on course names

This identification of core concepts in the course names is confirmed by the word counts on the course names, which is presented in table 4. The table shows eighteen concepts that are included in at least 3 course names.

Table 4 Word count on course names

Concept	Number (Percentage)
1. Spatial representation	29
2. Spatial infrastructure	15
3. Service	14
4. Web	12
5. Semantic	9
6. Metadata	7
7. Interoperability	7
8. Quality	6
9. Link	6
10. Standard	5
11. Knowledge	4
12. Technology	4
13. Application	3
14. Digital	3
15. Impact	3
16. Transformation	3
17. SDI	3
18. Geospatial	3

4.2. Course content

In a similar way, also the core concepts in the descriptions of the course content can be identified. Figure 2 shows the word cloud of the key concepts in the course content descriptions. Some concepts, such information, process(es), and (e)government seem to be more prominent in the course content (compared to the course names).

For the word count of the course content, a bigram was extracted, which means not single concepts, but combinations of concepts were investigated. This bigram, which is presented in table 5, provides some new insights, and reveals the importance of word combinations such as web services, API standards, semantic web, etc. While many of the concepts included in this table were also identified in the previous word clouds and word count, the bigram shows how these concepts often are used in combination with the same concept or concepts.

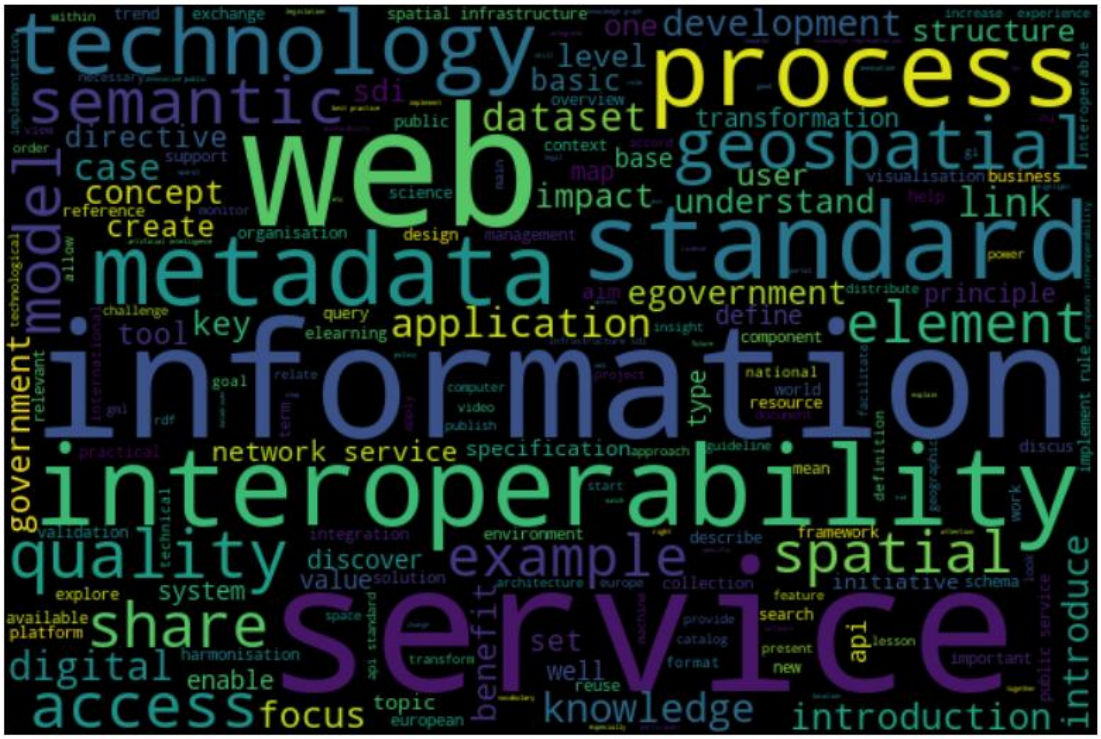

Figure 2 Word cloud on course content

Table 5 Word count on course content (bigram)

Concept	Frequency
1. Network service	15
2. Spatial infrastructure	13
3. Web service	11
4. Public service	11
5. Implement rule	10
6. API standard	8
7. Service share	7
8. Infrastructure (SDI)	7
9. European Interoperability	7
10. Artificial intelligence	7
11. Semantic web	7
12. Innovative public	6
13. Best practice	6

14. Knowledge representation	6
15. Knowledge graph	6
16. Geospatial service	5
17. Publish link	5
18. Spatial information	5
19. Geospatial quality	5

4.3. Learning outcomes

Information on the concepts or topics addressed in training courses also is included in the learning outcomes, which are defined and presented for most courses. The word cloud on learning outcomes, shown in figure 3, again demonstrates the importance of concepts such as standards, metadata, quality, services, APIs, etc. Interesting to notice is the information provided on the different verbs used in the learning outcomes, such as describing, understanding, creating and identifying. This is a nice indication of the precise levels of learning & understanding (according to Bloom's taxonomy) targeted in the training.

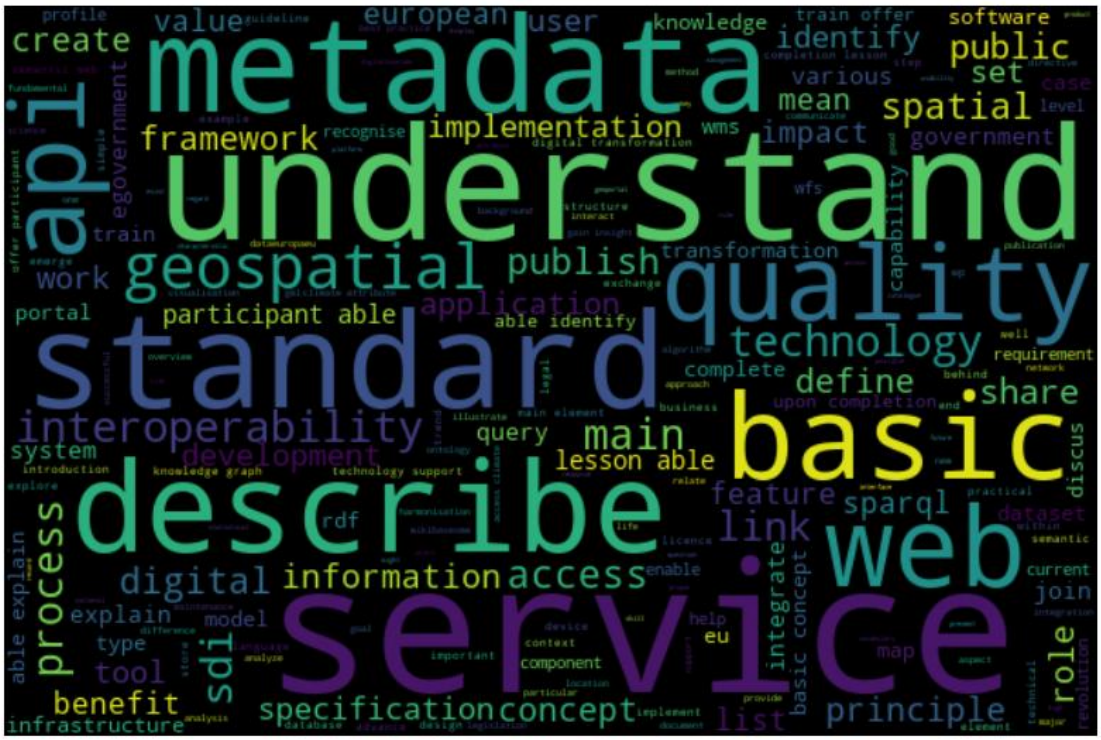

Figure 3 Word cloud on learning outcomes

4.4. Core topics

To conclude this chapter, we identify the core topics in the full course descriptions, i.e. the course names, course content and learning objectives. In table 6 and table 7, the word counts are provided on the complete course descriptions, with the aim to identify the core topics of the existing offer of training on location data interoperability.

Table 6 Word count on full course description

Concept	Frequency
1. Service	114
2. Web	72
3. Information	71
4. Metadata	67
5. Standard	67
6. Quality	58
7. Geospatial	57
8. Interoperability	56
9. Process	55
10. Technology	51
11. Access	44
12. Model	38
13. SDI	37
14. Application	36
15. Semantic	34
16. Spatial infrastructure	31
17. Knowledge	29
18. Government	28
19. Benefit	28
20. E-government	28
21. Sharing	28
22. Digital	26
23. Impact	25
24. Value	25
25. Tools	25

The word counts presented in table 6 confirms the relevance of key concepts already identified before, such as service(s), metadata, standards, quality, interoperability, process(es) and several other concepts. To better understand the context in which these concepts are used and identify relationships between concepts, table 7 provides the bigram counts, i.e. the frequency of sequences of two consecutive words.

Table 7 Word count on full course description (bigram)

Concept	Frequency
1. Spatial infrastructure	31
2. Network service	19
3. Public service	18
4. Web service	16
5. Semantic web	15
6. Representation spatial	15
7. Knowledge graph	14
8. Spatial representation	14
9. Service share	13
10. API standard	12
11. Digital transformation	12
12. European interoperability	11
13. Artificial intelligence	11
14. Implement rule	11
15. Innovative public	10
16. Best practice	10
17. Publish link	9
18. Measure impact	8
19. Web link	8
20. Infrastructure sdi	8
21. Standard api	7
22. Interoperability framework	7
23. Spatial infrastructure	31
24. Network service	19
25. Public service	18
26. Web service	16
27. Semantic web	15
28. Representation spatial	15
29. Knowledge graph	14
30. Spatial representation	14

5. Core topics

This chapter provides an in-depth investigation of 20 core topics that are central in the training courses included in the analysis. These topics were selected based on the word clouds and word count analyses presented in the previous chapter. For each topic, we show in this chapter the courses in which the topic is central, identify the related concepts and present the learning objectives that are associated with the topic.

5.1. Metadata

The concept of 'metadata' is central in seven of the training courses in our analysis. These courses are: '*Metadata, semantic enrichment and European Data Portal'; 'Improving open data and metadata quality', 'Spatial Representations and Spatial Data Infrastructures: Metadata and Catalogues'; 'Principles for Data and Metadata Harmonisation according to INSPIRE'; 'Procedures for Data and Metadata Harmonization'; 'Metadata and Data validation for INSPIRE'; and 'Metadata and Catalogue Services'.*

Figure 4 shows the concepts related to metadata, i.e. concepts that often appear in connection with the concept of Metadata.

Figure 4 Concepts related to Metadata

The courses included in our analysis contain several learning objectives on metadata, covering different levels of skills. Examples of such learning objectives are:

1. Learn which geospatial metadata profiles might need to be implemented in the European context, to support decision-making regarding metadata implementation within the context of a national metadata infrastructure
2. Learn why mapping is required between profiles and what mappings exist for the geospatial metadata profiles.
3. Know how and where this metadata is available and accessible through catalogues and who uses these profiles.
4. Understand the difference between a geoportal of a National Data Infrastructure and other open data portals such as the European Data Portal (EDP), and the information that each of them shows, taking into account the differences between metadata profiles.
5. Learn to make use of the metadata and enrich this metadata with semantic information.
6. Implement the tools and processes required to improve the findability and searchability of metadata online.
7. Read and interpret metadata records.
8. List and position basic metadata standards.
9. Describe a data set with the proper metadata.
10. Successfully complete a metadata-based search in a public catalogue.
11. Communicate the critical role of metadata for sharing geospatial data and services across distributed networks.
12. Recognize the legal background of INSPIRE data and metadata harmonization.
13. Explain the INSPIRE Data and Metadata Harmonisation steps.
14. Identify and describe the steps needed to perform a data/metadata harmonization.
15. Identify the suitable transformation tool(s), evaluate the complexity of a data/metadata harmonization process.
16. Validate existing metadata, create and validate INSPIRE compliant metadata, assess the conformity of an INSPIRE GML dataset.
17. Explain the role of metadata in data sharing and exchanging.
18. Outline the main metadata standards on spatial datasets and services.

5.2. Spatial Data Infrastructures (SDI)

The concept of ‘Spatial Data Infrastructures (SDI)’ is central in many of the courses in our analysis. Especially the course platform of the University of Salzburg offers several courses on SDI. Among the courses on SDI are: ‘*Spatial Representations and Spatial Data Infrastructures: Introduction and Overview’*, *‘Spatial Representations and Spatial Data Infrastructures: Standards for Interoperability’*, ‘*Spatial Representations and Spatial Data Infrastructures: Spatial Referencing as an SDI Foundation’* and ‘*Spatial Representations and Spatial Data Infrastructures: Geoportals as SDI Interfaces'* and *'Introduction to SDI Architecture and Components’*.

Figure 5 shows the concepts closely related to the concept of Spatial Data Infrastructure.

Figure 5 Concepts related to Spatial Data Infrastructures

Several learning objectives on Spatial Data Infrastructures could be identified:

1. Understand the motivation behind of SDI development.
2. Learn about different SDI frameworks.
3. Understand the importance of standards for integrated web architectures, like in SDI.
4. To recognise and describe the different components of an SDI.
5. To explain how these components work together in an SDI.
6. To explain how geoportals are a user interface to SDIs and their specific functions.
7. To identify the benefits of an SDI for her/his organisation.

5.3. Artificial Intelligence & machine learning

Several courses in our analysis are dealing with the concepts of artificial intelligence and machine learning. Among these courses are: *'Artificial Intelligence for geodata', 'Monitoring and understanding emerging geospatial technologies', 'Knowledge Graphs - Foundations and Applications', 'Innovative Public Services: Knowledge Exchange', 'Data Literacy – What is it and why does it matter?'* and *'Understand and Manage the Digital Transformation in the Workplace'.*

Figure 6 shows the concepts that are closely related to the concepts of artificial intelligence and machine learning.

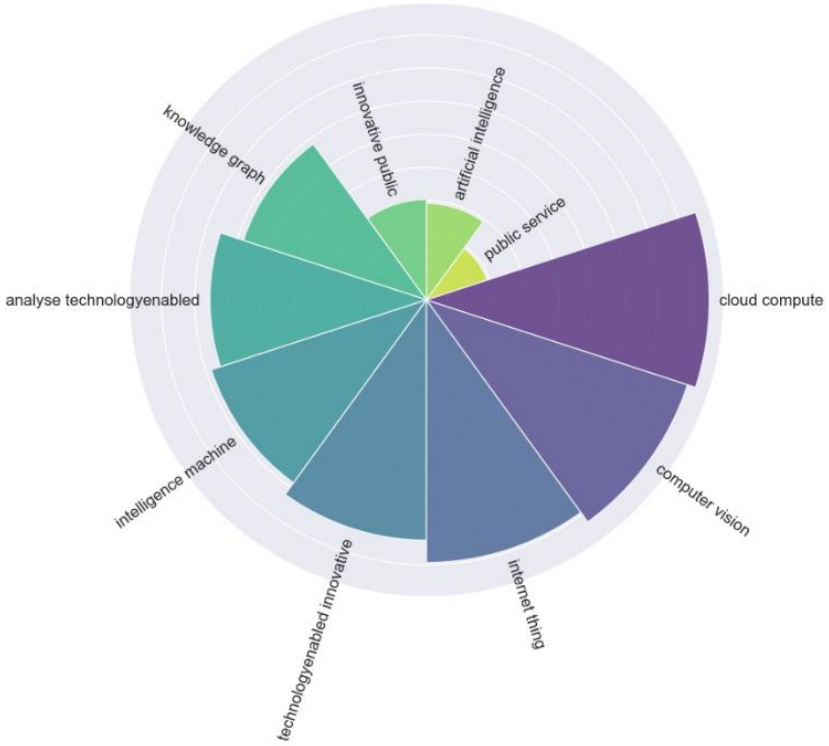

Figure 6 Concepts related to artificial intelligence and machine learning

There are several learning objectives on artificial intelligence and machine learning, such as:

1. Being able to describe artificial intelligence and determine what makes technology artificially intelligent
2. Identify current and potential future uses of artificial intelligence and explore the impacts, opportunities and risks of these on business and society
3. Learn the basic concepts, the tools, the development process and the criteria that allow you to evaluate how GeoAI can help solve your spatial problems.

5.4. Semantic web & linked data

The concepts of semantic web and linked data are central in seven courses in our analysis. These courses are*: 'Introduction to a Web of Linked Data MOOC', 'Publishing data with Linked Data Event Streams: why and how', 'Semantic Web Technologies', 'Introduction to Linked Data and the Semantic Web', 'Semantic Web and Linked Data', 'Introduction to Linked Data'* and *'Linked Data Advanced'.*

Figure 7 shows the set of concepts closely related to the semantic web and linked data concepts.

Figure 7 Concepts related to semantic web and linked data

The courses in our analysis contain several learning objectives on semantic web and linked data These include:

1. How to implement LDES on top of your existing dataset.
2. Learn the fundamentals of Semantic Web technologies.
3. Learn how to represent knowledge.
4. Learn how to access and benefit from semantic data on the Web.
5. Identifying Things with URI and RDF.
6. Querying RDF(S) with SPARQL.
7. Learn the applications in the Web of Data.

8. Reflect on why linked data is important for structuring the Web of Data.
9. Summarise the background technologies behind linked data.
10. Describe the various background standards behind linked data.
11. Explain what linked data is and what 5-star linked open data means.
12. Describe the basic concepts of SPARQL.
13. Apply knowledge of SPARQL to formulate SPARQL queries.
14. Design more advanced SPARQL queries.
15. Describe the practical applications for SPARQL and Linked Data.
16. Semantic Web and Linked Data concepts.
17. Data representation languages, such as RDF and JSON-LD.
18. Methodologies and technologies to support the generation and publication of Linked Data.
19. Ontologies and vocabularies used.
20. Relevant data sources data such as DBpedia.
21. Applications that make use of linked data.
22. Identify and describe the concepts of semantic web and linked data.
23. Explain the difference between linked and open data.
24. Identify the different steps in publishing linked data.
25. Understand how linked data can be consumed.
26. Understand the benefits of linked data.
27. After the training offer, the participant will be able to Identify and describe the basic principles of linked data.
28. Apply the guidelines for publishing linked data.
29. Understand URI and licensing strategies.
30. Understand the use of existing vocabularies and express data in RDF triples and set links to other data sources using OpenRefine.

5.5. Web services & network services

Web services and network services are two other – related – key concepts in our courses on (location) data interoperability. These concepts are central in several of the relevant courses we've identified. Among the courses on web services and network services are: '*Spatial Representations and Spatial Data Infrastructures: Web Map vs Web Feature Services', 'Spatial Representations and Spatial Data Infrastructures: Web Coverage / Image Services', 'Spatial Representations and Spatial Data Infrastructures: Web Processing Services', 'Introduction Open GIS Web Services', 'INSPIRE Network Services', 'Metadata and Catalogue Services,* and *'INSPIRE Network Services advanced'.*

Figure 8 shows which concepts in the course descriptions are most related to the concepts of network services and web services.

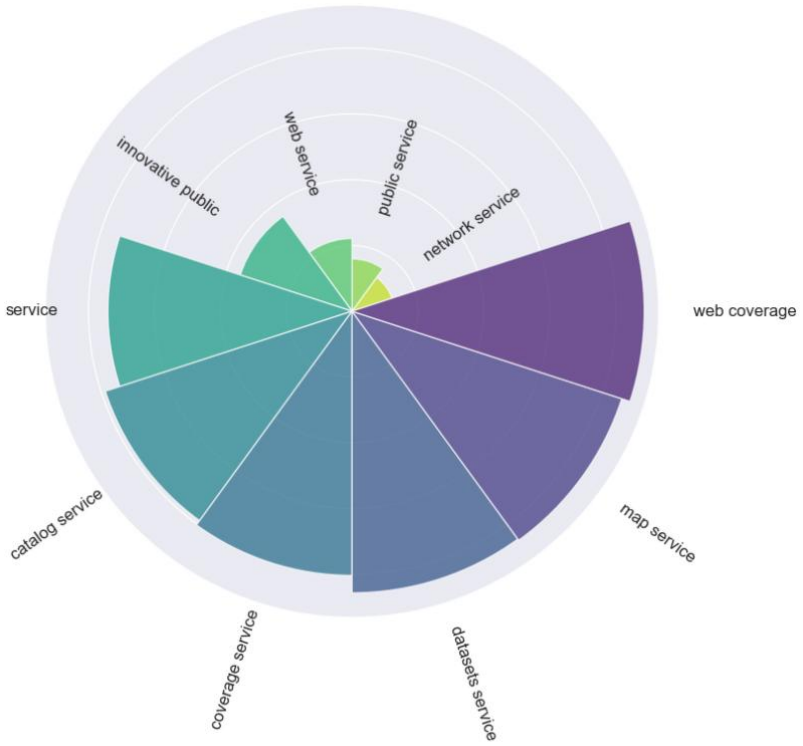

Figure 8 Concepts related to web services and network services

On the concepts of web services and network services, we could identify several learning objectives in the course descriptions. Examples of such learning objectives are:

1. Distinguish the characteristics and relative merits of WMS vs WFS
2. Embed layers of a WMS as well as WFS into a web map
3. Take a geospatial data set and publish it as a WMS
4. Access your shared service from another client or (mobile) device
5. Access gridded geospatial data not only as WMS, but also as image services
6. Integrate WCS into web maps
7. Explain WCS service descriptions
8. Use image services as a basis for simple analyses
9. Being able to explain basic concepts of WPS.
10. Explore the capabilities of WP services
11. Use existing WPS workflows
12. Design simple processing chains (workflows) based on WPS
13. Access capabilities and layers of published WMTS
14. Integrate a WMTS into a map display and work across cached layers
15. Explore one or more vector tile services.
16. Experiment with styling of vector tile services.
17. Learn the meaning of terms such as WMS, WFS, WCS, SOS, WPS, CSW, ...
18. Gain insight into the possibilities of Open GIS Web Services.

19. To identify and describe the principles and concepts of web service technology and the main characteristics of web services.
20. To list and describe the specifications of the OGC standard for a (Catalogue Service for the Web (CSW), a Web Map Service (WMS) and a Web Feature Service (WFS) and provide examples for each of them.
21. To recognise and explain the new OGC API standards approach.
22. To identify some good examples of WMS/WFS Clients and Servers and give examples for each of them.
23. To make the link between the INSPIRE network services and those international standards
24. To identify and describe the main elements of INSPIRE conformant metadata for services.
25. To identify and describe the main elements of the INSPIRE geoportal.
26. To identify and describe the performance and capacity guidelines and some test tools/suites.
27. Outline the main metadata standards on spatial datasets and services.
28. Explain the role of catalog services in data sharing.
29. Describe the concept of distributed Catalog Service as well as its underlying principles.
30. Set up an operational WFS and test the quality of the service capabilities and attributes.
31. Set up an operational CSW and test the quality of the service capabilities and attributes.

5.6. Management

Management is another core concept in our courses, and is central in two courses: '*Data Management'* and '*Service Management'*.

Figure 9 shows the concepts that are related to the 'Management' concept.

There are no learning objectives explicitly dealing with 'Management', but several related learning objectives could be identified. Examples of such learning objectives are:

1. How to make your data more available and findable
2. How to improve your metadata to meet the requirements of the modern-day spatial data infrastructures.
3. How to automatically improve the quality of your data.
4. How to publish your quality information in a visual way.
5. To learn skills to create the future of sharing location information using the family of OGC API standards

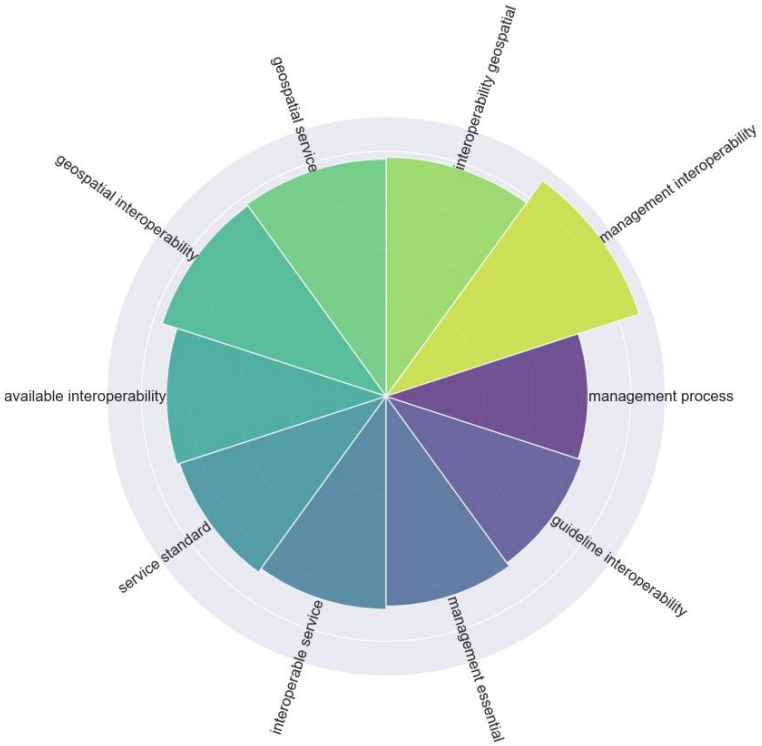

Figure 9 Concepts related to Management

5.7. Harmonization

Also ‘Harmonization’ was identified as a core concept in the course descriptions. Twelve different courses dealing with harmonization could be identified, including courses such as *‘Semantic and Organisational Interoperability’, ‘Joining Spatial and Statistical Data’, ‘Meteorological data integration’, ‘Interoperability: An introductory course’*, *‘Principles for Data and Metadata Harmonisation according to INSPIRE’*, *‘Data Harmonisation’*, *‘Procedures for Data and Metadata Harmonization’, and ‘INSPIRE Advanced’.*

Figure 10 shows the various concepts that are closely related to the concept of harmonization.

Figure 10 Concepts related to Harmonization

In total 34 different learning objectives could be identified related to the concept of harmonization. A few examples of such learning objectives are:

1. Learn the basic characteristics of statistical and geospatial data, and how they can be joined by using the OGC API – Joins service
2. Understand basics of climate data availability in Europe and the steps required to harmonise climate data across country borders
3. Understand the principles of interoperability and harmonisation in INSPIRE
4. Recognise the legal background of INSPIRE data and metadata harmonisation
5. Define and describe the basic concepts of data harmonisation and schema translation.
6. Identify and describe the steps needed to perform a data/metadata harmonization, identify the applicable regulations/guidelines needed in an harmonization and/or validation process, identify the suitable transformation tool(s), evaluate the complexity of a data/metadata harmonization process
7. Define and discuss the main opportunities and challenges of integrated INSPIRE services in e-Government
8. Recognize and illustrate the cross-border usability of the INSPIRE services using case-studies and success stories

5.8. Interoperability

While all the courses included in the analysis to some extent deal with interoperability, there are seven courses in which interoperability is the central concept. These courses are: *'Semantic and Organisational Interoperability'*, *'EU Interoperability Academy: Innovative Public Services (Knowledge Exchange'*, *'European Interoperability Framework (EIF) Online Training'*, *'Interoperability: An introductory course'*, *'Interoperability'*, *'Spatial Representations and Spatial Data Infrastructures: Standards for Interoperability'* and *'ArcGIS Data Interoperability in Action''*

Figure 11 shows the concepts that are related to the interoperability concept.

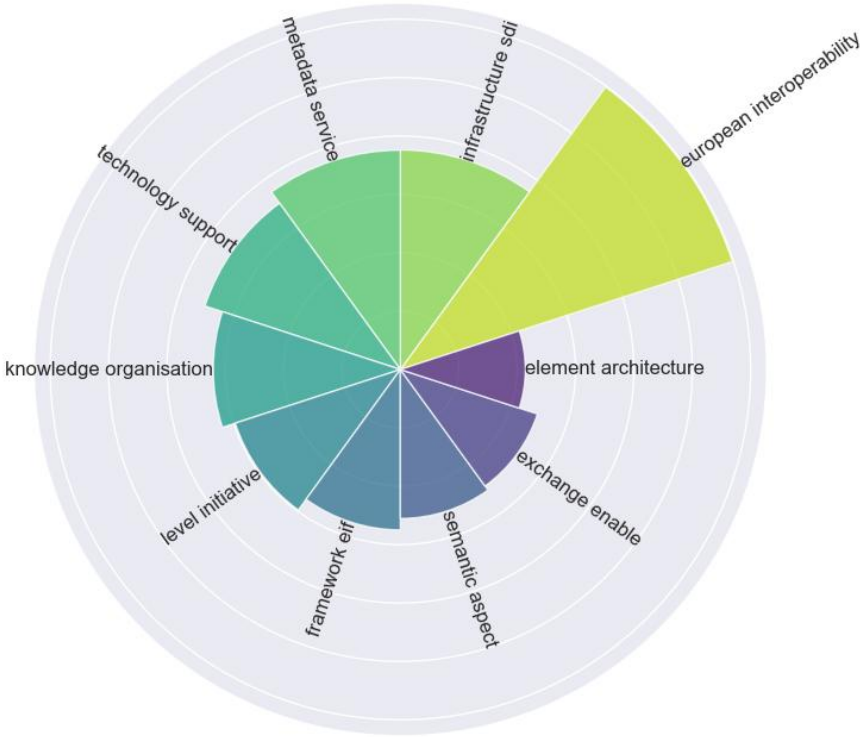

Figure 11 Concepts related to Interoperability

In the course descriptions, there are several learning objectives focusing explicitly on interoperability. Examples of such learning objectives are:

1. Understand what interoperability means, what it requires for data, metadata, and services to be interoperable, and how this can be handled at the organisational and semantic interoperability levels.

2. Understand the main areas covered by the European Interoperability Framework (EIF) with the goal of achieving fully integrated digital public services by Member States and any public administration
3. Provide the definition of interoperability identify / describe the main European Interoperability Framework concepts the main enablers and the main barriers for achieving interoperability
4. Articulate the need for Interoperability and how the concepts of the European Interoperability Framework and respective initiatives facilitate the implementation of significant legal acts for cross border services in the European Economic Area
5. Identify, locate, assess, reusable tools and participate to communities that accelerate the creation of a interoperable public services and develop the required advance digital skills.
6. Define the meaning and assumptions of the interoperability of IT large scale systems in order to exchange data and enable information exchange
7. Distinguish individual systems ultimately included in the interoperability framework and managed by various EU agencies and used by end users in Member States
8. Identify the current status of EU preparations for system interoperability, including legal background
9. Understand how to apply data transformation tools within interoperability workspaces.
10. Create interoperability tools that live within the geoprocessing environment on the desktop and in enterprise scenarios

5.9. API

API could also be considered as a core topic in the courses and course descriptions. Three courses explicitly deal with API (standards): '*Common Aspects of the OGC API Standards', 'Other OGC API Standards', and 'Applications for OGC APIs'.*

In figure 12 the concepts closely related to the API concept are presented.

Learning objectives on API can especially be found in these three courses in which API (standards) are central. Among these learning objectives are:

1. Learn the basic structure of OGC APIs and how resources, such as landing pages, API definitions and conformances are used in OGC APIs and what they mean.
2. Learn basic practices and requirements for all other OGC APIs
3. Understand why to use pygeoapi, how to install pygeoapi and set up your first OGC API.
4. Understand when and why to use the family of OGC API - Joins standards. This helps to join geospatial and/or statistical data with OGC API Joins.
5. Understand when and why to use the OGC API Records. This to discover, access, query and publish metadata about geospatial resources and services on the Web through the OGC API Records.
6. Understand when, how and why to use the OGC API Processes. This helps to process geospatial data on the Web through the standard.

7. Understand what benefits OGC metadata provides both the service provider and the user and how the quality of metadata improves the usability of OGC API.
8. How to use OGC API Features in QGIS
9. Understand the basic differences between the Web Feature Service (WFS) protocol and OGC API Features
10. How the GeoServer displays data via the OGC API Features (OAPIF)

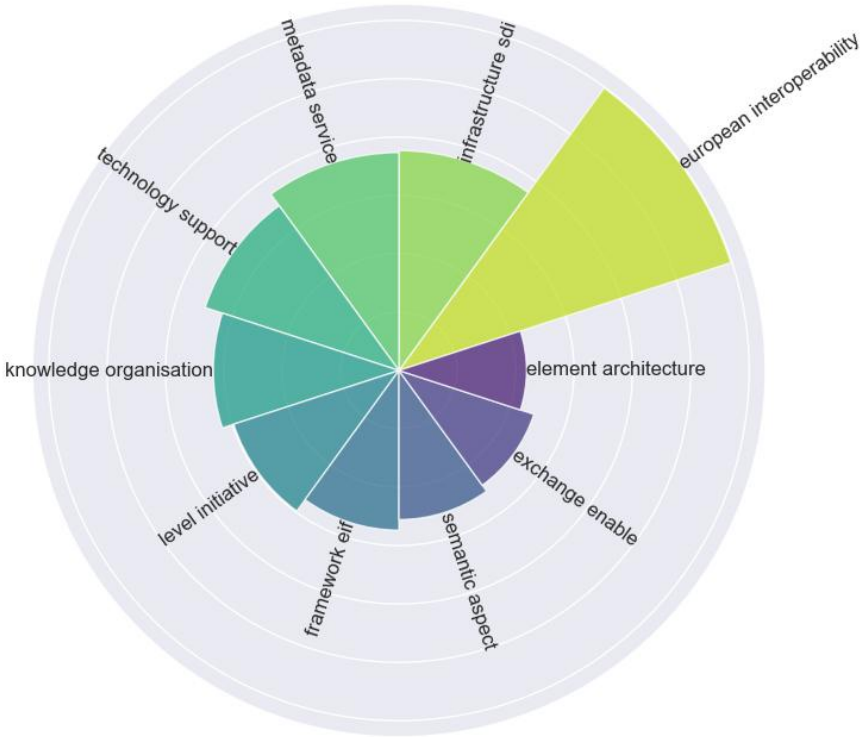

Figure 12 Concepts related to API

5.10. Government & Policy

Government and Policy are central courses in several of the courses that were identified as relevant courses. Examples of such courses are ‘‘*Measuring the impact of open data', 'Open and Smart Government MOOC', 'Introducing open data : What is open data?', 'Understanding data governance with open data',* and *'From INSPIRE to e-Government'.*

Figure 13 shows the concepts that are closely related to the concepts of Government and Policy.

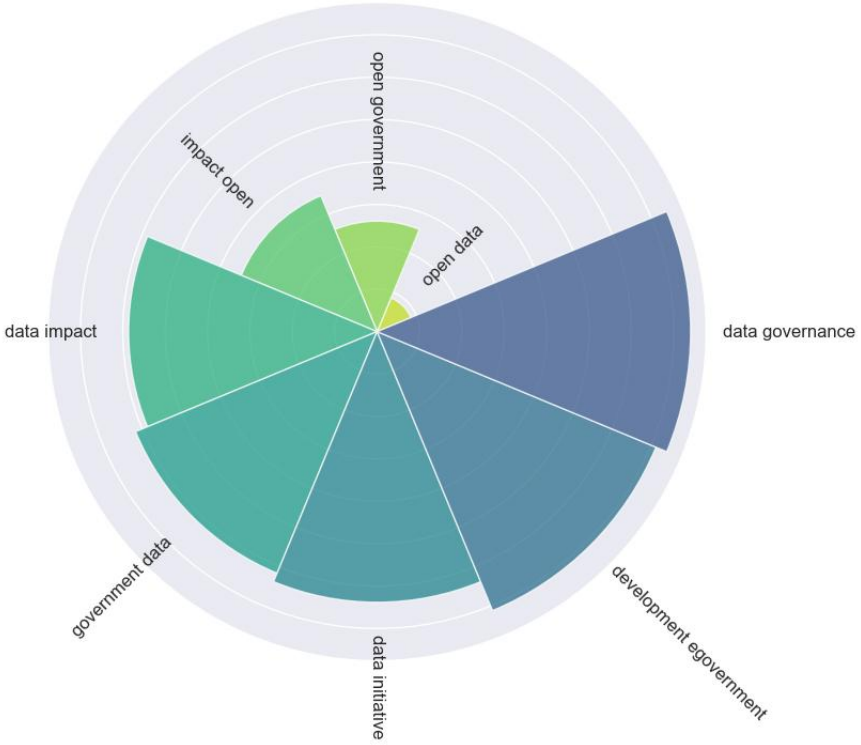

Figure 13 Concepts related to Government and Policy

On Government and Policy, there are many learning objectives in the different course descriptions. Examples of such learning objectives are:

1. Understand the significance of open data and its potential impact on businesses and society
2. Analyze case studies of successful open data initiatives and identify best practices
3. Analyze and discuss benefits, barriers and potential negative effects of a particular open government case
4. Analyze public values and best practices related to open government
5. Apply the open government principles in various situations
6. Understand potential negative and positive effects Open Government might bring to the workplace
7. Define and discuss the main opportunities and challenges of integrated INSPIRE services in e-Government
8. Discuss and facilitate publishing of own data under an open licence

5.11. Knowledge graphs

The concept of Knowledge graphs can be seen as another core concept, and is central in two of the courses: ‘Knowledge Graphs - Foundations and Applications’ and ‘Knowledge Graphs’.

Figure 14 shows the main concepts related to the concept of Knowledge graphs.

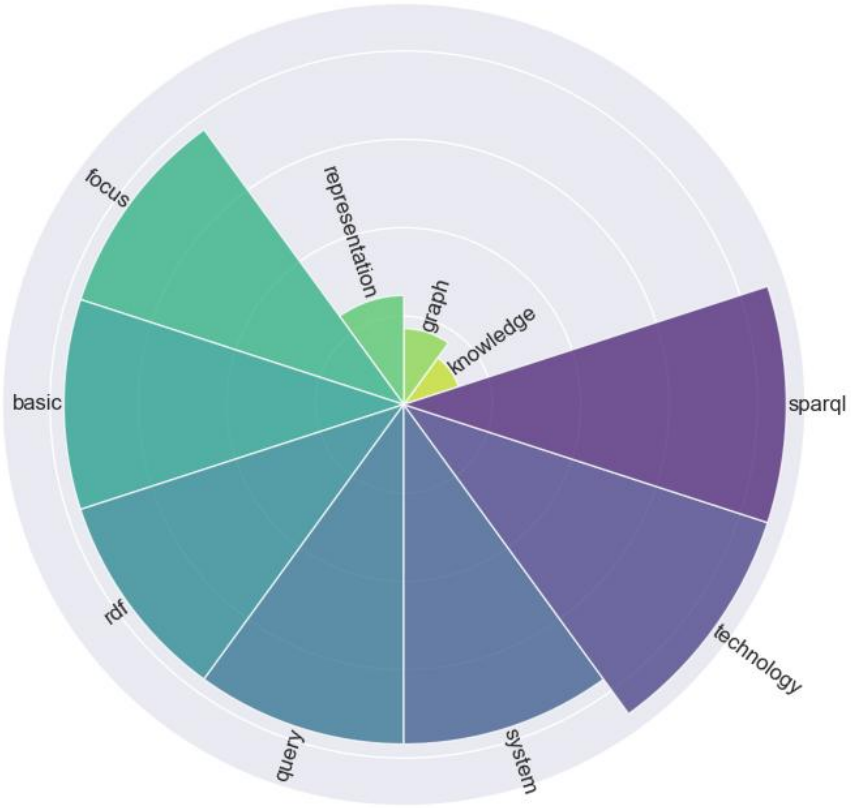

Figure 14 Concepts related to Knowledge Graphs

On this concept, there are several learning outcomes, especially from the two courses on the topic. Among these learning outcomes are:

1. Basic understanding of knowledge graphs
2. Basic understanding of ontologies.
3. Basic understanding of Semantic Web Technologies.
4. Basic understanding of ontology design and knowledge graph construction.
5. Basic understanding of knowledge graph embeddings.
6. Knowledge Graphs in the Web of Data.
7. Basic Semantic Technologies.

8. Querying RDF with SPARQL.
9. Knowledge Representation with Ontologies.
10. Knowledge Graph Applications.

5.12. Open data

The concept of 'Open data' is central in many of the courses in our analysis. There are nineteen courses dealing with open data, including courses such as *'Open Data and Licences', 'Measuring the impact of open data', 'Understanding the legal side of open data', 'Understanding data governance with open data'* and *'Open data from theory to practice: data that creates value'.*

Figure 15 shows the concepts in the course descriptions that are related to open data.

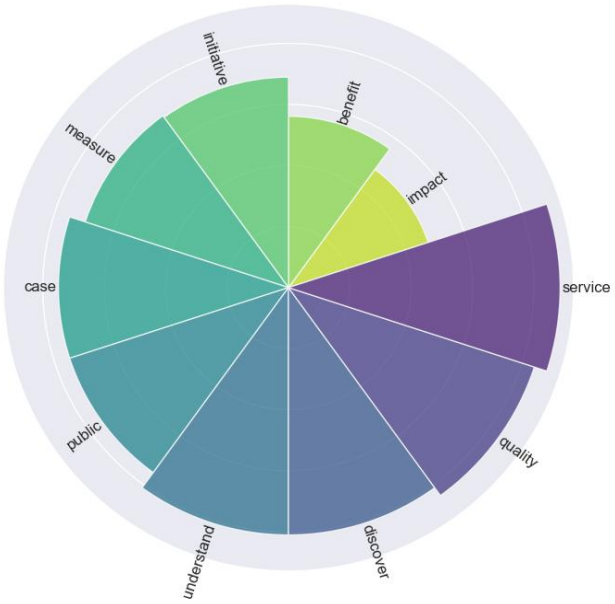

Figure 15 Concepts related to Open data

Since there are many courses on open data, also a large number of learning objectives on open data could be identified. Among such learning objectives are:

1. Get to know the basics of spatial data and open data.
2. Know what licences are used for open spatial data and open-source software.
3. Understand the significance of open data and its potential impact on businesses and society.
4. Develop an impact assessment framework for open data initiatives.
5. Select appropriate metrics and indicators to measure open data impact.

6. Utilize data analysis and visualization tools to measure open data impact.
7. Analyze case studies of successful open data initiatives and identify best practices.
8. Learn the full potential of open data.
9. Understanding successful approaches to unlock the value of open data.
10. Understand how data.europa.eu can be the perfect solution for one's open data needs.
11. Have the skills to start publishing and promoting open data for citizens to access.
12. Understand how to use open data to create a new product or service or develop it and take it to the next level.
13. The value of open data in the public and private sector.
14. Understand what makes quality open data.

5.13. Legal /Legislation

Also 'Legal' and 'Legislation' are central concepts in the identified courses and their course descriptions. They are addressed in eight different courses, including courses such as *'Data Literacy – What is it and why does it matter?', Introducing open data', 'Understanding the legal side of open data'* and *'INSPIRE Data and service sharing'.*

In figure 16 the concepts that are closely related to 'Legal' and 'Legislation' are presented.

In terms of learning objectives, there are several learning objectives dealing with or related to the concepts of 'Legal' and 'Legislation'.

1. Gain a deeper understanding of the current legal challenges on the use and distribution of open data through existing and upcoming legislation, on topics such as intellectual property or data protection.
2. Recognise the legal background of INSPIRE data and metadata harmonisation.
3. Understand and explain the main elements of the INSPIRE Directive (objective, principles) chapter on Data and Service Sharing.
4. To define and summarize the main requirements of the INSPIRE Regulation harmonising access to data and services.
5. Describe and discuss the state of the art of INSPIRE data and service sharing and exemplify how to report on data-sharing agreements.
6. Describe and discuss the issues relating to the implementation of the legislation by a data provider.
7. Explain how the current legislation and its implementation impacts on third parties and to illustrate and comment on the success of the current legislation in achieving its goals

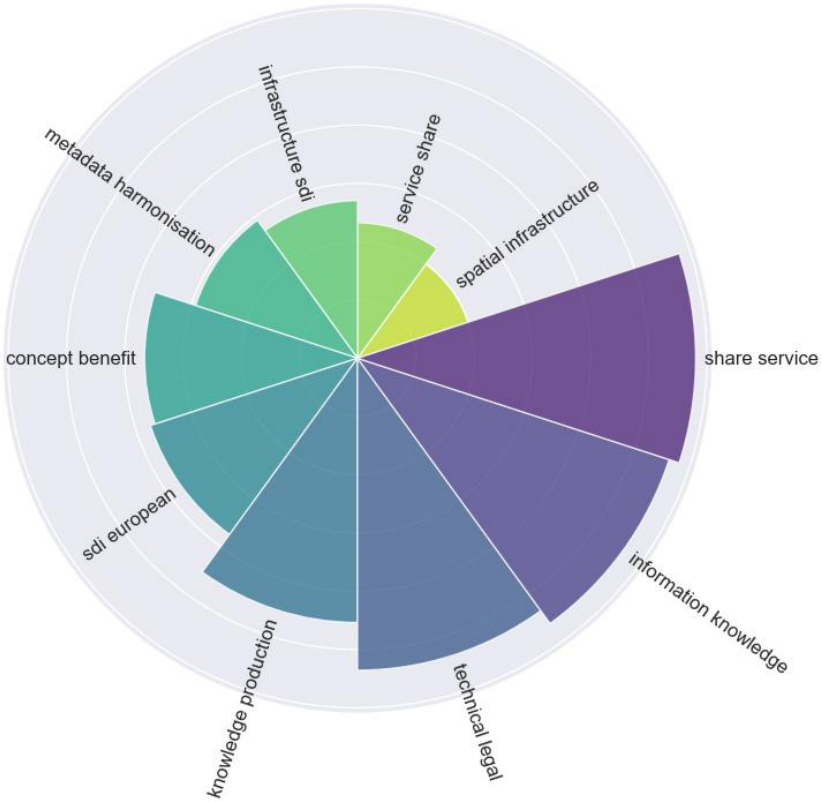

Figure 16 Concepts related to Legal & Legislation

5.14. Sharing

Sharing is another core concept in the course descriptions, as it is a central concept in seven different courses: *'Data Management', 'Service Management', 'EU Interoperability Academy: Innovative Public Services (Knowledge Exchange)', 'Data Literacy – What is it and why does it matter?', 'Innovative Public Services: Knowledge Exchange', 'Introducing open data : What is open data?'* and *'Spatial Representations and Spatial Data Infrastructures: Web Coverage / Image Services'.*

Figure 17 shows the concepts that are strongly related to the concept of sharing.

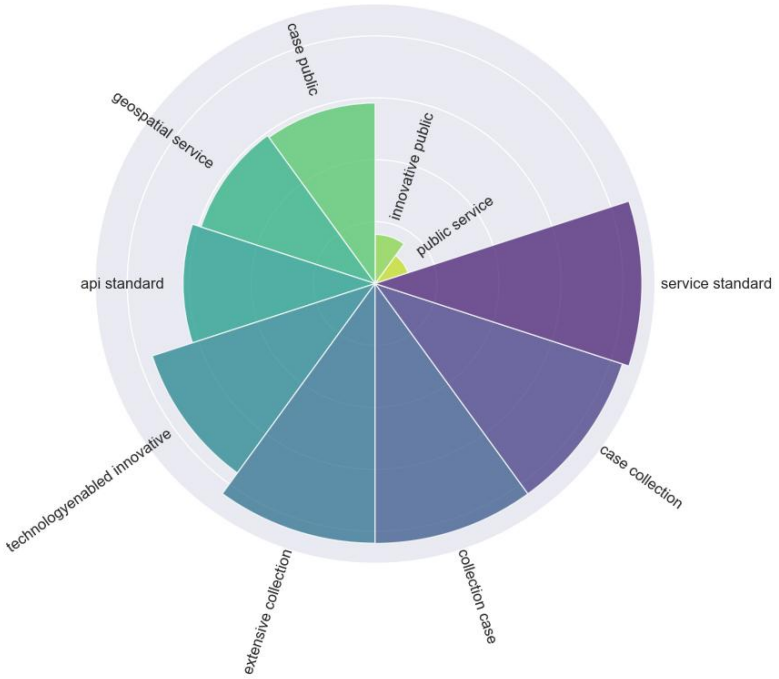

Figure 17 Concepts related to Sharing

Looking into the learning objectives of the courses in the analysis, and particularly the courses on sharing, there are several learning objectives related to sharing. Among these learning objectives are:

1. Make your data more available and findable.
2. Improve your metadata to meet the requirements of the modern-day spatial data infrastructures.
3. Automatically improve the quality of your data.
4. Publish your quality information in a visual way.
5. Create the future of sharing location information using the family of OGC API standards.
6. Identify, understand and interpret the roles of digital technology in everyday life as well as their ability to grasp when data-driven technologies bring benefits and are aligned with human needs and values.
7. Acquire knowledge from use cases of emerging technologies to support Innovative Public Services.
8. Understand what open data is and why it matters
9. Know the key elements of open data, like how it drives digital transformation.

5.15. Visualization

Visualization is a central concept in several of the courses included in our analysis. Among the courses on visualization are: *'Including data in your communication', 'Introducing data visualization', 'Inspiring through data visualization'* and *'Geo-Spatial and web technologies'.*

Figure 18 shows the concepts from the course descriptions that are related to the concept of visualization.

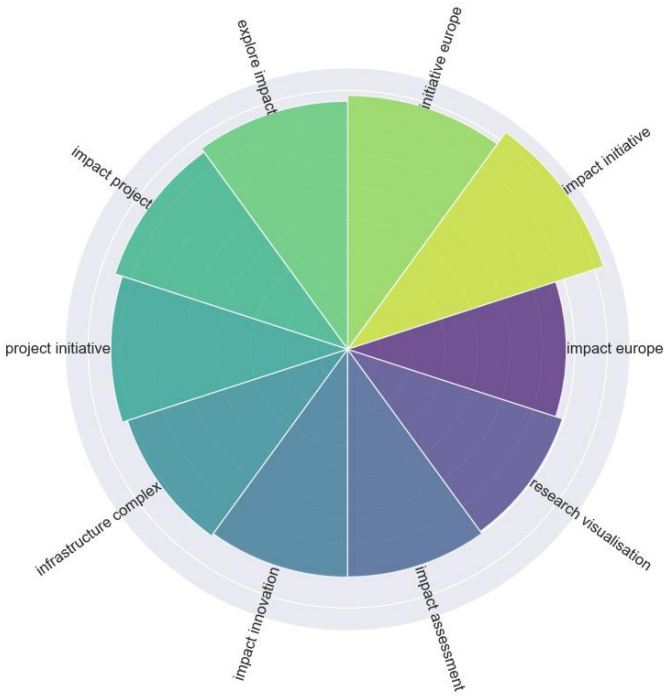

Figure 18 Visualization

In the collection of courses and their descriptions, there are several learning objectives related to the concept of visualization.

1. Utilize data analysis and visualization tools to measure open data impact
2. How to communicate complex economic topics
3. Storytelling using hyper-visual presentations
4. How to make meaningful maps
5. Using data art for science communication
6. Transforming printed publications to interactive digital tools
7. How to make your data easier to visualise
8. Accessibility in data visualisation

9. Ethics in data visualisation
10. Data visualization aesthetics
11. Guidelines for effective data visualisation
12. How algorithms and machine learning to create data visualisation

5.16. (Data) quality

There are several courses dealing with (data) quality, which can be seen as another core concept. Among the courses on (data) quality are: '*Data Quality Assurance', 'Quality Dashboards', 'Improving open data and metadata quality', 'Open data from theory to practice: quality and validation', 'Quality aspects of geodata', and 'Data Quality.'*

Figure 19 shows the concept that are most closely related to the concept of (data) quality.

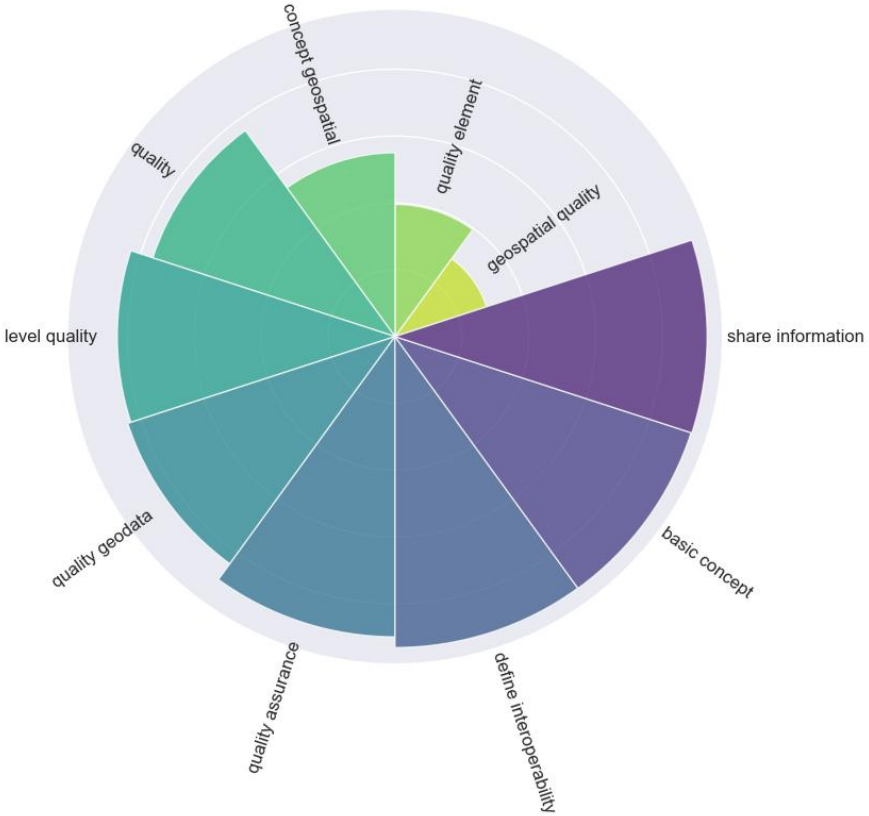

Figure 19 Concepts related to (Data) Quality

There are many learning objectives dealing implicitly or explicitly with (data) quality, such as:

1. How to automatically improve the quality of your data
2. How to publish your quality information in a visual way
3. Basic principles of data quality management, including the most common vocabulary, methods, and quality elements.
4. How high data quality can be achieved with the aid of quality rules.
5. How to apply selected quality rules automatically to your data using quality software.
6. Understand the main steps of the data quality management process and recognise the role of automated quality software.
7. What a service and data quality dashboard is and whether such a dashboard could provide value for the learner's data platform.
8. Gain insight into the various aspects of geodata quality
9. Monitor the quality of your geodata
10. Define and describe the basic concepts of geospatial data quality.

5.17. (Data) Models

Another core concept in the courses is (data) models. There are several courses in which this concept is addressed such as '*Semantic Modelling', 'Spatial Representations and Spatial Data Infrastructures: Basic Representations of Spatial Entities', 'Open data from theory to practice: modelling and enrichment', 'Basic concepts of XML and GML', 'INSPIRE Data Specifications', 'Data Harmonisation', 'Procedures for Data and Metadata Harmonization'* and *'Examples of Data Transformation'.*

In figure 20 the concepts most closely related to (data) models are shown.

In the courses and course descriptions, there are many learning objectives on data models and data modelling: Read and understand basic GML (Geography Markup Language) markup code

1. Understand how data modelling Increases the value of the data itself, as misinterpretation of the data becomes less likely when context is provided.
2. Explain why INSPIRE requires data specifications (interoperability)
3. Explain the development process of INSPIRE data specifications
4. Understand the main elements of the INSPIRE modelling framework (generic conceptual model)
5. Explain how data specifications have been modelled
6. Understand the process of data transformation and start using data transformation tools to transform data into INSPIRE compliant data.
7. When completing this module, the learner is expected to be able to define and describe the basic concepts of data harmonisation and schema translation.
8. identify and describe the steps needed to perform a data/metadata harmonization

9. Identify the applicable regulations/guidelines needed in an harmonization and/or validation process,
10. Identify the suitable transformation tool(s),
11. evaluate the complexity of a data/metadata harmonization process.
12. Identify and understand the source and target data models,

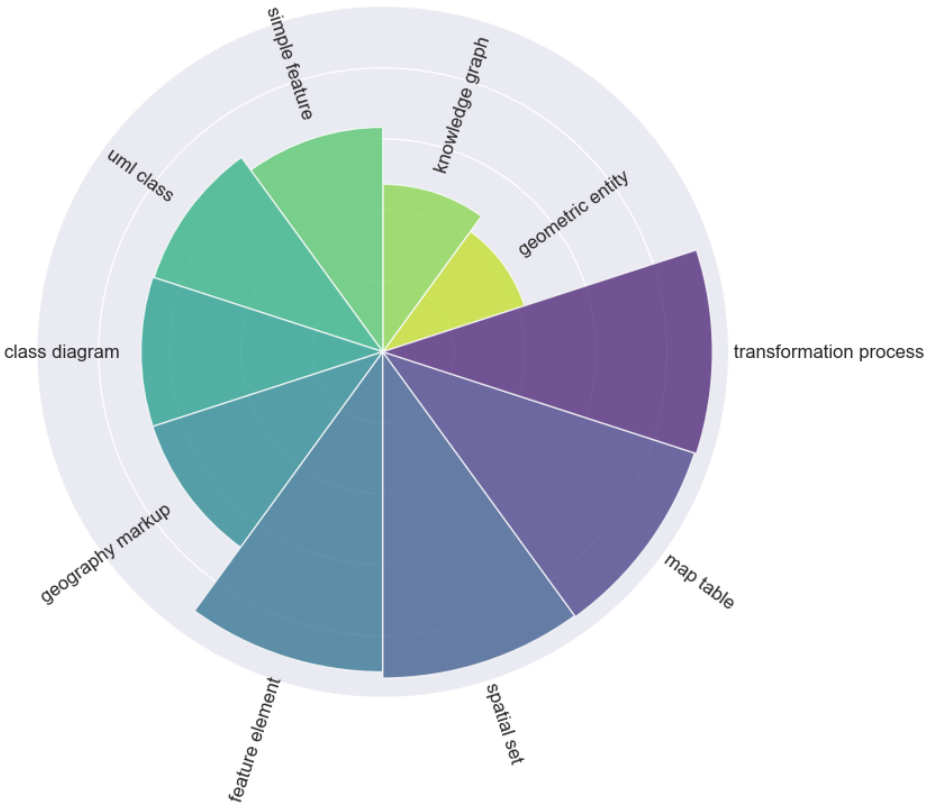

Figure 20 Concepts related to (Data) Models

5.18. Data spaces

A relatively new concept that can be considered as central in several of the courses is the concept of ‘Data Spaces’, which is covered in the courses ‘Data and Service Integration’, ‘Moving towards data spaces’ and ‘Understanding data governance with open data’.

Figure 21 shows the concepts that are (strongly) related to the data spaces concept in the different course descriptions.

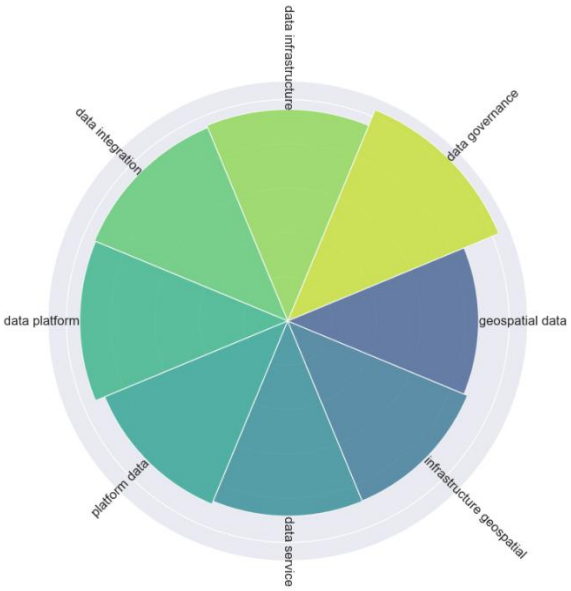

Figure 21 Concepts related to Data spaces

In the course descriptions, there are some learning objectives on data spaces:

1. Understand the basic principles of data and service integration
2. Join geospatial and statistical data
3. Integrate geospatial and meteorological data
4. Use and fetch data from different types of APIs, including OGC APIs
5. Understand the role of data.europa.eu in EU data spaces

5.19. Digital transformation & Digital technology

Two related concepts that are central in several of the courses are 'Digital transformation' and 'Digital technology'. Both topics are covered in four different courses, namely '*Impact from Digital Transformation', 'Digitalisation of Construction SMEs', 'The Digital Revolution'* and *'Understand and Manage the Digital Transformation in the Workplace'.*

Figure 22 shows the different concepts most closely related to Digital transformation & digital technology.

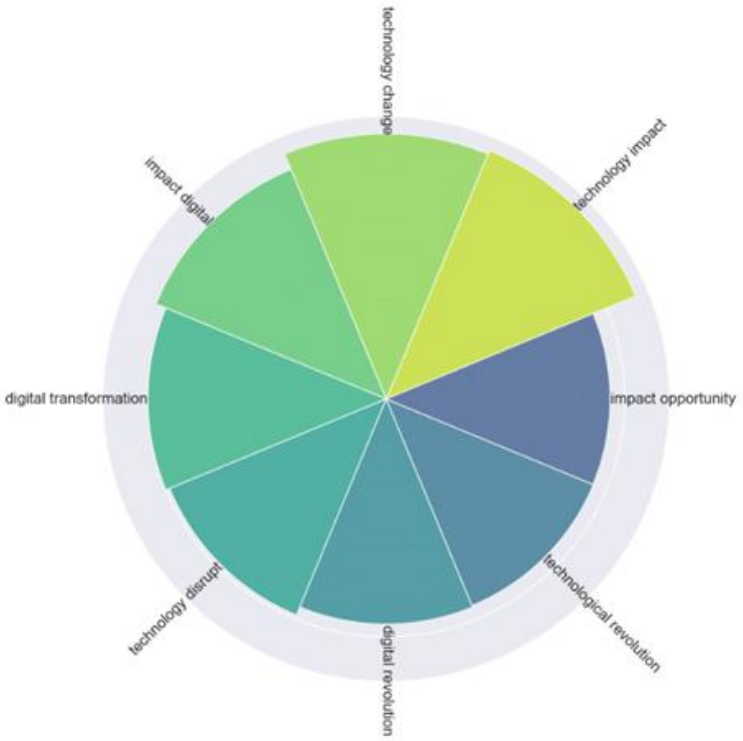

Figure 22 Concepts related to Digital transformation & Digital technology

There also are several learning objectives defined related to the two concepts of Digital transformation and Digital Technology. Examples of such learning objectives are:

1. Be able to explain what the digital transformation is, and how the digitalisation of services and products has evolved to become embedded in virtually all industrial and economic sectors.
2. Be able to define drivers of the digital transformation and explain essential concepts related to technology's impact on the world of work - and social and daily life.
3. Explain why you need a digital transformation strategy
4. Explain how to remove cultural barriers towards digitalisation
5. Explain how to start integrating digital technologies

5.20. Public Services

Besides web services and webservices also ‘Public services’ can be seen as a core concept in the current offer of training on location data interoperability. In our analysis, we’ve included two courses focussing on public services: ‘*EU Interoperability Academy: Innovative Public Services’* and ‘*European Interoperability Framework (EIF) Online Training’*.

In figure 23 an overview is provided of the main concepts related to the concepts of ‘public services’.

Figure 23 Concepts related to Public Services

A few learning objectives on public services could be identified from our course descriptions:

1. Acquire knowledge from use cases of emerging technologies to support Innovative Public Services.
2. Gain a solid understanding of the main areas covered by the European Interoperability Framework (EIF) with the goal of achieving fully integrated digital public services by Member States and any public administration.
3. Get a good understanding of the main components of the EIF and how to apply them in a real-world scenario, thanks to a practical case.

6. Cluster analysis

In this chapter, we further investigate the (inter)connections between concepts in the course descriptions, by identifying clusters of related concepts and creating a concept network in which the relationships between concepts are visualized. A cluster analysis entails studying relationships between the different courses on offer. It is a method used to group similar data points together based on their inherent characteristics or attributes. Here the course descriptions were the main datapoints used to determine which courses have enough similarity to belong in the same cluster. Applying this method to our training course descriptions, seven clusters of concepts could be identified:

1. **Spatial Data Infrastructures cluster**, including concepts (or covering topics) such as network services, spatial (data) infrastructures, web services, geospatial quality, implementing rule(s), catalogue service, metadata standards and other.

2. **Legal/Governance cluster**, including concepts (or covering topics) such as: open data licences, international law, basic interoperability, selecting right licence, software licences among others.

3. **Interoperability cluster,** including concepts (or covering topics) such as: European interoperability framework, business process, e-government development, share information, interoperability reference and other.

4. **Standards cluster,** including concepts (or covering topics) such as: API standard, event stream, share geospatial data, geospatial web, web service, interoperability standard, access standard feature among others.

5. **Data sharing and access cluster,** including concepts (or covering topics) such as: 'service share, implement rule, spatial infrastructure, geospatial service, infrastructure defaces share, facilitate access, and rule conformity.

6. **Digital transformation cluster** including concepts (or covering topics) such as public services, public service innovation, digital transformation, artificial intelligence, impact measurement, new and emerging technologies, digital revolution, and other.

7. **Knowledge representation**, including concepts (or covering topics) such as: knowledge graph, semantic web, semantic element, representation knowledge, knowledge production, semantic query among others.

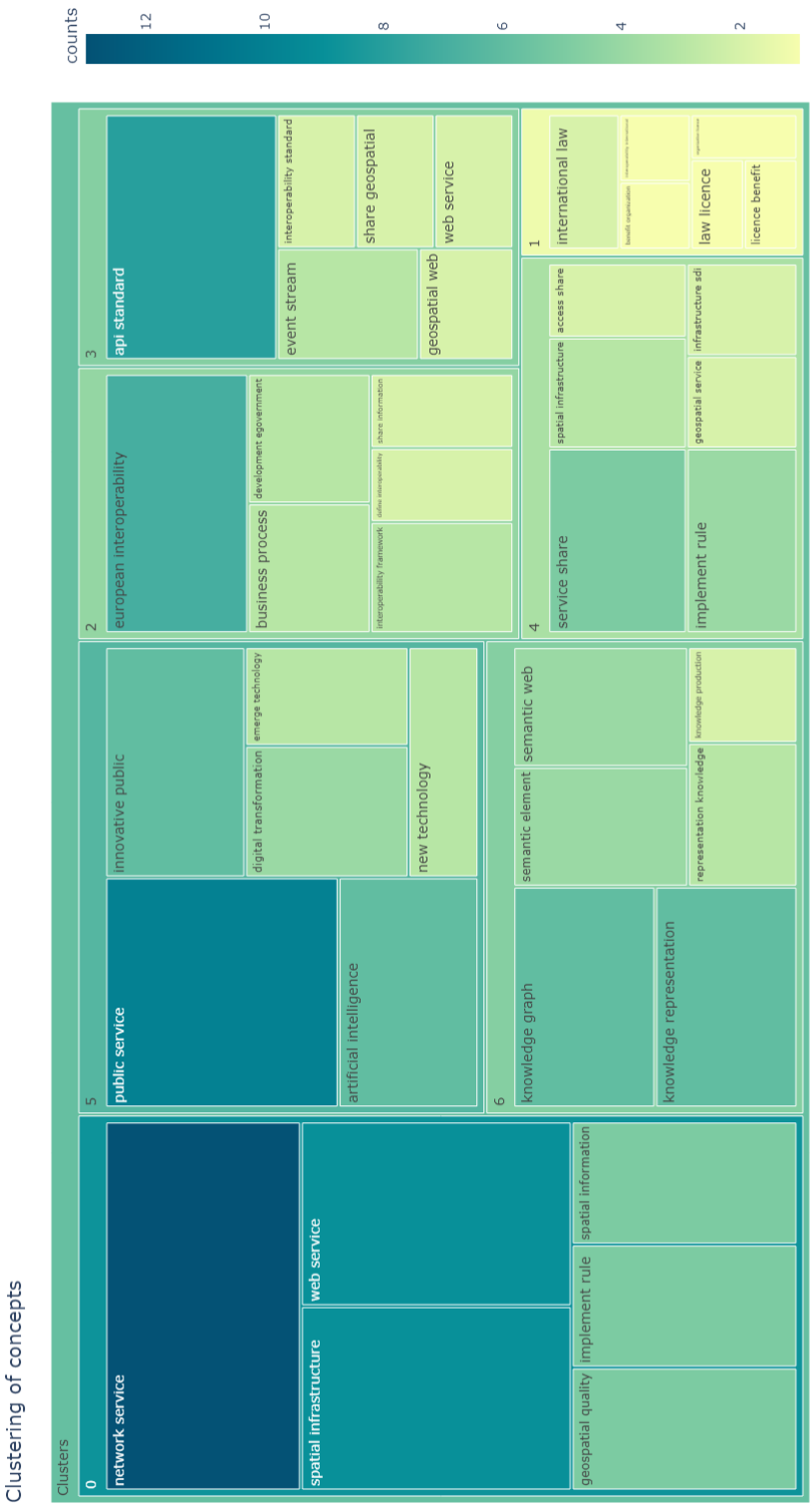

Figure 24 Cluster diagram of key concepts

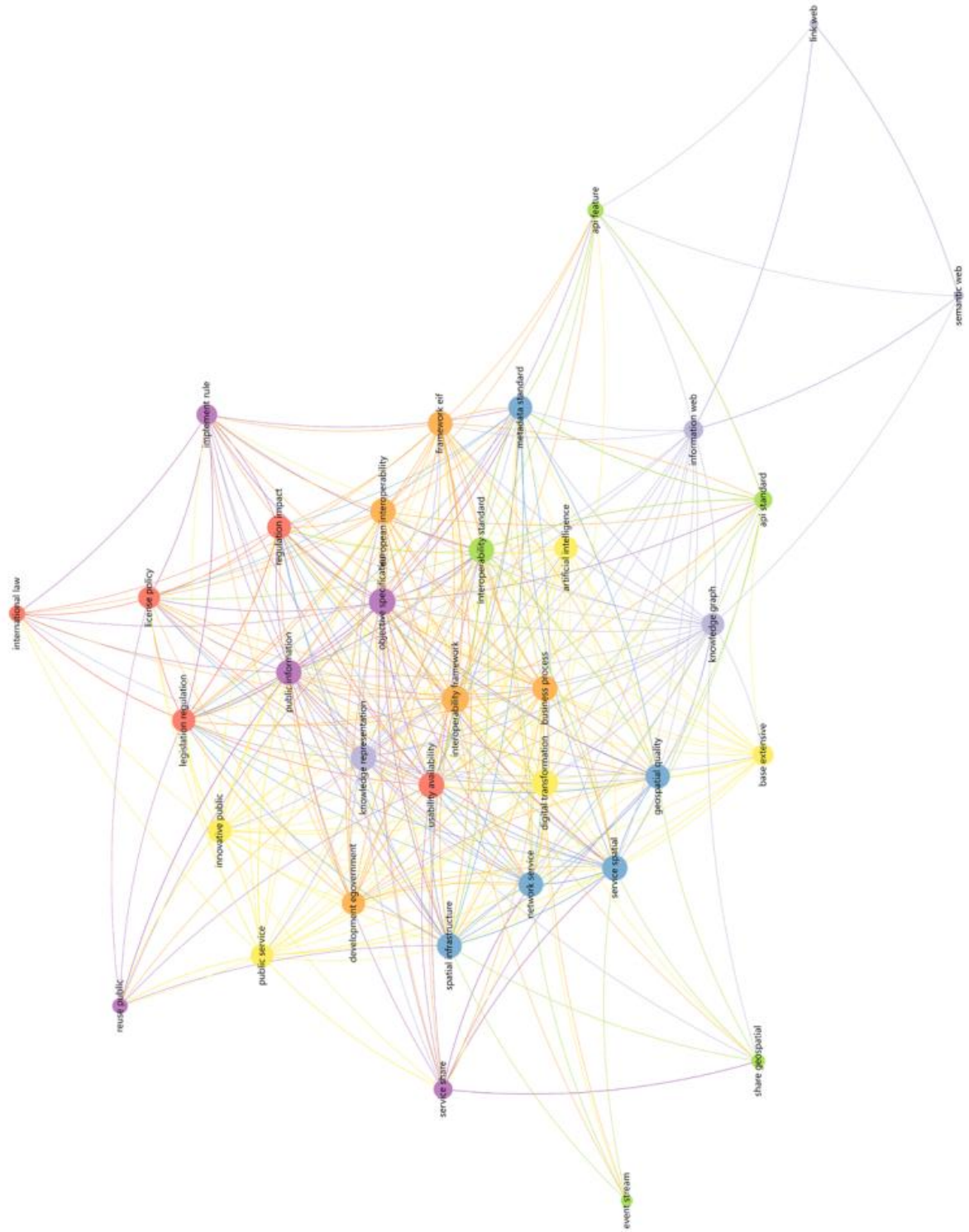

Figure 25 Concept network diagram

The cluster tree map presented in figure 24 shows the main concepts per cluster and their relevance. Several concepts appear in different clusters, demonstrating a connection between the courses being offered. This gives us an indication of course contents that are generally offered together.

Figure 25 shows the concept network of the course descriptions, in which the core concepts identified in the course descriptions are presented, as well as the relationships between these concepts. This concept network builds upon the cluster analysis by performing a similarity evaluation of the concepts in the clusters. As each of the clusters contain courses with various concepts therein, these concepts may be repeated in other clusters, thus creating either weak or strong relationships between the different clusters. A similarity analysis compares the concepts to each other, and produces a similarity index, which is then used to create a network diagram.

A further analysis of the network diagram reveals some concepts that have a higher degree of relationship to other concepts. This demonstrates the connection between concepts and increases the understanding of the interconnectedness between different courses. Some main concepts and related concepts are presented in table 8.

Table 8 Overview of main concepts and related concepts

Concept	**Related Concepts**
Interoperability	interoperability standard, European interoperability framework, spatial infrastructure, (data) usability availability', knowledge representation, metadata standard, digital transformation, service spatial, business process, legislation regulation, development e-government, geospatial quality, regulation impact, knowledge graph, artificial intelligence, implement rule, network service, innovative public, API standard, public information, license policy, measure impact
Network service	service spatial, service api, public service, service share, business process, interoperability framework, interoperability standard, digital transformation, usability availability, European interoperability, public information, spatial infrastructure, knowledge representation, development e-government, innovative public
Spatial infrastructure	service spatial, interoperability framework, digital transformation, usability availability, geospatial quality, interoperability standard, knowledge representation, framework eif, European interoperability, development e-government, knowledge graph, regulation impact, artificial intelligence, metadata standard, measure impact, business process, legislation regulation, network service, innovative public, public information

link web	information web, semantic web
regulation impact	measure impact, legislation regulation, usability availability, development e-government, interoperability framework, European interoperability, knowledge representation, interoperability standard, spatial infrastructure, business process, digital transformation, public information, implement rule, innovative public, artificial intelligence, framework eif, license policy
Interoperability standard	interoperability framework, metadata standard, usability availability, European interoperability, api standard, geospatial quality, framework eif, knowledge representation, spatial infrastructure, digital transformation, service spatial, regulation impact, legislation regulation, network service, artificial intelligence, business process, development e-government, implement rule, knowledge graph, measure impact, innovative public, public information, license policy, public service
metadata standard	interoperability standard, API standard, interoperability framework, framework EIF, usability availability, geospatial quality, European interoperability, knowledge graph, digital transformation, spatial infrastructure, service spatial, knowledge representation, API feature
API standard	metadata standard, interoperability standard, API feature, service API, interoperability framework, European interoperability framework
Services API	network service, service spatial, public service, service share, API standard
Spatial infrastructure	service spatial, interoperability framework, digital transformation, usability availability, geospatial quality, interoperability standard, knowledge representation, framework eif, European interoperability, development e-government, knowledge graph, regulation impact, artificial intelligence, metadata standard, measure impact, business process, legislation regulation, network service, innovative public, public information
Legislation regulation	regulation impact, implement rule, interoperability framework, public information, international law, license policy, development e-government, knowledge representation, European interoperability, interoperability standard, usability availability, 'innovative public, 'framework eif, business process, public service, spatial infrastructure, digital transformation
Knowledge representation	knowledge graph, interoperability framework, spatial infrastructure, framework eif, metadata standard, artificial intelligence, interoperability standard, service spatial, digital transformation, geospatial quality
Digital transformation	interoperability framework, spatial infrastructure, development e-government, interoperability standard, innovative public, knowledge representation,

	business process, european interoperability, service spatial, usability availability, artificial intelligence, geospatial quality, network service, public information, metadata standard, regulation impact, framework eif, legislation regulation, knowledge graph
E-government development	digital transformation, interoperability framework, regulation impact, knowledge representation, European interoperability, usability availability, legislation regulation, spatial infrastructure, innovative public, business process, interoperability standard, artificial intelligence, service spatial, public information, framework eif, network service, geospatial quality
License/Legislation	legislation regulation, implement rule, international law, interoperability framework, public information, business process, public service, interoperability standard, regulation impact
(Data) usability availability	interoperability standard, interoperability framework, geospatial quality, European interoperability, regulation impact, spatial infrastructure, service spatial, knowledge representation, development e-government, digital transformation, measure impact, metadata standard, business process, legislation regulation, public information, network service, artificial intelligence, innovative public, public service, framework eif
International law	license policy, legislation regulation, regulation impact, implement rule, public information, objective specification, European interoperability framework, public service, innovative public, knowledge representation

7. Conclusion

The aim of this report was to provide insight into the offer of training in Europe on location data interoperability and related topics, by mapping and analysing existing courses on these topics. A combination of manual and (semi-)automated approaches and methods was used for the discovery of relevant courses, the collection of data on these courses and the analysis of these courses and their content.

The analysis and results presented in this report give a better understanding of the current status and trends in offering location data interoperability training in Europe. Based on input collected via desk research, consultations with the DIS4SME project partners, and some basic web crawling techniques we were able to discover and collect information on almost 100 training courses related to the topic of (location) data interoperability. Using some typical text analytics techniques an in-depth analysis was made of the topics covered in these existing training courses.

The training courses that were taken into consideration can be categorized into two main groups: while there are several courses dealing with GI, GIS and especially SDIs (and topics related to these), there's also a big group of courses focusing on (open) data and (digital) technology in general. To a certain extent these courses are overlapping, i.e. covering similar topics, but they also can be considered as complementary. For the future design and development of the DIS4SME courses, it can be argued that it is important to take into consideration both groups of courses, when dealing with a particular topic.

An important result of this study is the identification of the core concepts in the existing offer of training, and the inventory of courses, other concepts and learning objectives to each of these concepts. This supports the assessment of the skills gaps, shortages and mismatches on location data interoperability as well as the design and development of new training and training materials. The clustering of related concepts and courses reveals the broader topics of the current training offer: Spatial Data Infrastructures, Legal/Governance, Interoperability, Standards, Data sharing and access, Digital transformation and Knowledge representation.

Based on the approaches and methods applied in this study some recommendations for next steps and future studies can be drawn. From the analysis and results it can be seen that the discovery and selection of courses has a strong impact on the results and findings of the analysis. Therefore, effort should be done to gain a more complete and up-to-date overview of the existing offer of courses. Especially the collection of face-to-face training courses and of courses in national languages is challenging but will lead to a more representative set of courses. The application of text analytics for investigating the content of the courses can be considered as an inspiring approach, which uncovers new insights.