



D6.2

FAIR training materials catalogue & integration with Common Training Platform

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Deliverable abstract

This deliverable provides an overview of the developed FAIR training materials, including a description of how these have been integrated into the Common Training Platform. Considering the relevant role assumed by the WP6 within the project, all the aspects behind the design, the development and the implementation and population of both the training catalogue and the training platform are presented. A special focus is reserved to the metadata set adopted for the learning resources, that is often representing a mature and successful case study in several projects/initiatives.



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DOCUMENT AMENDMENT PROCEDURE

Amendments, comments and suggestions should be sent to the Project Manager at manager@envri-fair.eu as well as to the lead author (lucia.vaira@lifewatch.eu).

GLOSSARY

A relevant project glossary is included in Appendix A. The latest version of the master list of the glossary is available at <http://doi.org/10.5281/zenodo.4471374>.

PROJECT SUMMARY

ENVRI-FAIR is the connection of the ESFRI Cluster of Environmental Research Infrastructures (ENVRI) to the European Open Science Cloud (EOSC). Participating research infrastructures (RI) of the environmental domain cover the subdomains Atmosphere, Marine, Solid Earth and Biodiversity / Ecosystems and thus the Earth system in its full complexity.

The overarching goal is that at the end of the proposed project, all participating RIs have built a set of FAIR data services which enhances the efficiency and productivity of researchers, supports innovation, enables data- and knowledge-based decisions and connects the ENVRI Cluster to the EOSC.

This goal is reached by: (1) well defined community policies and standards on all steps of the data life cycle, aligned with the wider European policies, as well as with international developments; (2) each participating RI will have sustainable, transparent and auditable data services, for each step of data life cycle, compliant to the FAIR principles. (3) the focus of the proposed work is put on the implementation of prototypes for testing pre-production services at each RI; the catalogue of prepared services is defined for each RI independently, depending on the maturity of the involved RIs; (4) the complete set of thematic data services and tools provided by the ENVRI cluster is exposed under the EOSC catalogue of services.

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D6.2 - FAIR training materials catalogue & integration with Common Training Platform

1 Introduction and background

1.1 About Work Package 6 and this deliverable

The objective of ENVRI-FAIR Work Package 6 is to provide training to ENVRI and key ENVRI stakeholder groups about the FAIR (Findable, Accessible, Interoperable, and Reusable) principles, how to implement them in RI services and data management activities at data centre level, and how to evaluate the degree of implementation using FAIR metrics, as well as relevant legal and policy requirements.

This deliverable, D6.2, is an output of Task 6.2, “Training RIs (in and outside of ENVRI-FAIR) on FAIR implementation on data centres”. As outlined in the Description of Actions, this task shall concern itself with a summary of the developed FAIR training materials, including a description of how these have been integrated into the Common Training Platform.

To this extent, LifeWatch ERIC has defined a metadata schema for training objects and developed a training catalogue in order to allow ENVRI data centres and RIs to easily search, discover and access the training resources. As planned, the ENVRI Training Catalogue has been firstly populated with the training materials coming from the deliverable 6.1 (see Milestone 22¹) and then also other ENVRI-FAIR training events. Consequently, the ENVRI Community Training Portal (CTP) has also been updated.

These two major outcomes are introduced in the following paragraphs and then analysed in more detail in dedicated chapters.

1.2 Developing FAIR training materials

This activity aimed at responding to the growing international need for the development and cataloguing of FAIR training materials. This need originated from the fact that, even if a large number of educational resources are currently available through various platforms, such resources are not always easy to find and to integrate into a learning course due to the unavailability of their required metadata.

Therefore, in the implementation of this deliverable, a number of actions were undertaken in order to respond to this challenge developing and making available training materials that employ FAIR best practices in their design.

Here some of the followed FAIR criteria:

- Findability: metadata are registered and indexed in a searchable resource.
- Accessibility: metadata are retrievable by their identifier using a standardised communications protocol, a protocol that is open, free, and universally implementable. Moreover, it allows for an authentication and authorisation procedure, when necessary.
- Interoperability: metadata use a formal, accessible, shared, and broadly applicable language for knowledge representation.
- Reusability: metadata are richly described with a plurality of accurate and relevant attributes and are released with a clear and accessible data usage license.

¹ Milestone 22: Training materials for the ENVRI data centers are produced and available at the training portal https://envri.eu/wp-content/uploads/2020/07/MS22_WP6_Training-materials-for-the-ENVRI-data-centers-are-produced-and-available-at-the-training-portal.pdf

The metadata of the educational resources developed by following these principles and criteria, are hosted in an open web catalogue, the ENVRI-FAIR Training Catalogue (<https://trainingcatalogue.envri.eu>), in order to be searched, discovered and accessed.

Initially, a total of 34 training resources have been annotated with metadata, starting from the training resources and materials related to FAIR data principles and Research Data Management listed in Table 2 of Deliverable 6.1, and then made available for use in the catalogue.

The topics of these training resources come from a gap analysis built to avoid duplication of efforts and are mainly distinguished into “general FAIR-related” and “research data management-related”. Then, for each ENVRI-FAIR training event, a Learning Object² has been created in the catalogue.

1.3 Creating an integrated common training platform

To guarantee continuity with the ENVRIplus project³, we improved and customised the already existing training platform based on the Moodle Learning Management System (LMS)⁴ according to our needs and requirements.

Besides the fact that Moodle is open source, and that it is a fairly simple web application written in PHP language, another advantage of Moodle is indeed the possibility to greatly extend and customize the platform. Moreover, it is interoperable by design to enable integration of external applications and information onto a single Moodle platform. Indeed, Moodle is certified Learning Tool Interoperability (LTI) Advantage Complete, a certification that is a global technical standard of integrating learning applications. This means that users can integrate and present externally hosted applications and content within a single Moodle platform without having to develop and maintain custom integrations.

The developed training platform includes all ENVRI community eTraining and eLearning courses that are listed in the metadata catalogue. It is possible to access to the training material directly from the catalogue by using the “Start” button on the right side of the detail page of a given resource (see Figure 3 of the 2.4 section). Moreover, users may also find the same list of the available courses in the integrated common training platform homepage.

More details about the training platform, available at <https://training.envri.eu> can be found in chapter 3.

1.4 Training target groups

There is a number of different target groups for the ENVRI-FAIR training activities. Some details on their level of involvement in the training are presented in this section.

The primary target group for the training is the staff at the ENVRI data centres, especially those concerned with data management and service architecture. This group benefits both from self-paced study activities and from tutorial sessions organized in connection to project collaboration meetings and webinars.

A second important target group for the training is the staff of data centres of key local, regional and national institutions dealing with environmental data. In fact, many RIs are concerned with coordinating and disseminating data products (and services) produced by external contributors. These data provider communities also benefit from training in FAIR practices.

² A Learning Object is defined as any entity, digital or non-digital, that is used for learning, education, or training; a metadata instance for a learning object describes relevant characteristics of the learning object to which it applies (IEEE 1484.12.1-2020 - IEEE Standard for Learning Object Metadata)

³ ENVRIplus project: <https://cordis.europa.eu/project/id/654182>

⁴ Moodle home page: [1] <https://www.moodle.org>

A third important target group comprises early-career scientists (MS and PhD students and post-docs) associated with the ENVRI and their end user communities.

1.5 Monitoring and evaluation

The monitoring and continuous improvement of both training catalogue and training platform is a key aspect for the usability and the user friendliness. One of the relevant ingredients is the feedback from users that is very useful to understand needs, issues, missing features, etc. and to improve accordingly.

In May 2020 we invite the representatives of the four subdomains (atmosphere, marine, solid earth, biodiversity and ecosystem) to provide a feedback for both the training catalogue and the training platform.

The questions were mainly related to easiness of use, login/registration functionalities, search form easiness, usefulness of Milestone 22 as guideline, overall satisfaction in a rating scale from 0 to 5.

All aspects received a very good feedback (an average of 3,8 over 5) and the milestone 22 was very appreciated as guideline. The training catalogue resulted easier to use with respect to the training platform, and the overall satisfaction was also slightly higher.

Starting from these suggestions we decided to set up a “Training catalogue/platform working group” within the WP6 in which we started brainstorming on the main tasks of the working group that have the final aim to continuously monitor and improve the catalogue and platform functionalities by following the user feedback. Some preliminary outputs are for example:

- from the training catalogue perspective, as this catalogue will grow with time, the first page should be an invitation to a search-table;
- from the training platform perspective, it is needed to make an introduction on how to use Moodle as student and as teacher in order to increase the use of the platform by different users.

2 FAIR Training Catalogue and background

2.1 Materials and methods

In order to create an open catalogue of training resources for the partners of the ENVRI-FAIR project, which can be used by the educational world (scientific communities, students, ordinary citizens, etc.) the following activities have been considered:

1. the identification of the metadata set necessary for the research and discovery of the most suitable training resources
2. the design of the catalogue of training resources. In particular:
 - the identification of the main functional/technical requirements
 - the evaluation of already existing applications that meet these requirements by highlighting both strengths and weaknesses
 - the development and description of a minimal set of training resources by using the identified metadata and their publication within the catalogue
3. the implementation of the training catalogue. In particular:
 - the identification of already existing training resources used by other scientific communities or by other research infrastructures
 - the implementation of a metadata catalogue able to index resource based on the identified metadata.

The home page of the training catalogue, available at <https://trainingcatalogue.envri.eu> is shown in Figure 1.

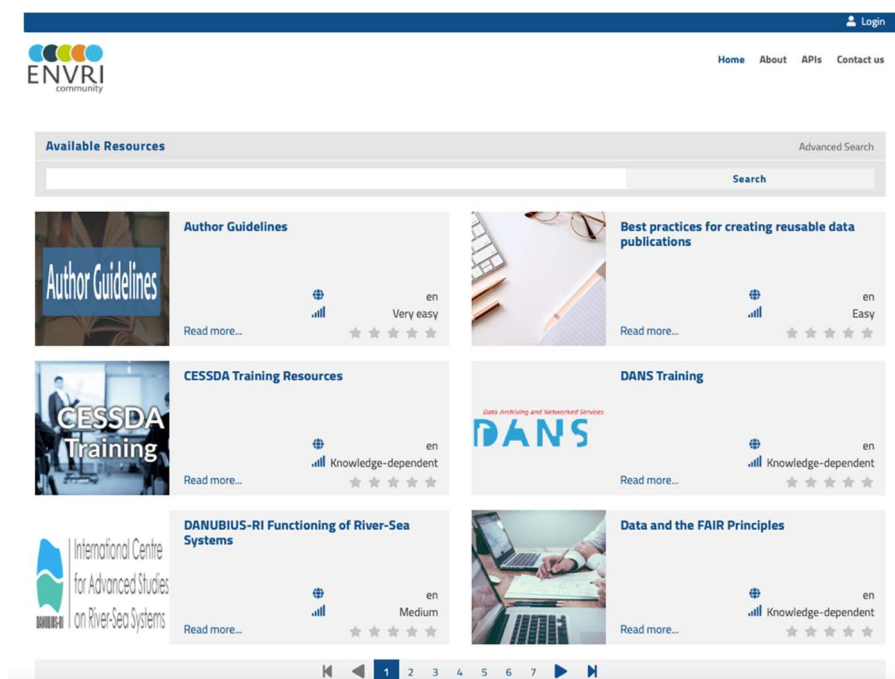


Figure 1. ENVRI-FAIR Training Catalogue home page - <https://trainingcatalogue.envri.eu>

2.1.1 The adopted metadata standard

The IEEE 1484.12.1 – 2002 Standard for Learning Object Metadata⁵ (LOM) is an internationally recognised open standard (published by the Institute of Electrical and Electronics Engineers Standards Association) for the description of “learning objects”. IEEE 1484.12.1 is the first part of a multipart standard and describes the LOM data model. The LOM data model specifies which aspects of a learning object should be described and what vocabularies may be used for these descriptions.

The LOM developed for this catalogue includes a hierarchy of four main elements. At the first level, there are therefore four categories, each of which contains sub-elements that are simple elements containing data. The data model also specifies the value space and datatype for each of the simple data elements. Some fields also accept multivalued data.

The IEEE LOM consists of 60 optional elements that can be used to describe learning objects. Such elements can be combined in various manners to describe the pedagogical intent of an educational resource. This flexibility is important as the IEEE LOM can be too complex for novice catalogues. Indeed, for the ENVRI Training Catalogue, a profile with 27 metadata elements have been considered (with respect to the 60 elements available within the IEEE LOM standard).

In particular, the following IEEE LOM elements have been considered:

1. **General:** this category groups the general information that describes the learning object as a whole
 - 1.1 **Identifier:** a globally unique label that identifies the learning object
 - 1.2 **Catalog:** The name or designator of the identification or cataloguing scheme for this entry. A namespace scheme. E.g., URI, ISBN, ARIADNE, etc.
 - 1.3 **Entry:** the value of the identifier within the identification or cataloguing scheme that designates or identifies the learning object. A namespace specific string
 - 1.4. **Title:** name given to the learning object
 - 1.5. **Language:** the primary human language or languages used within the learning object to communicate to the intended user
 - 1.6. **Description:** a textual description of the content of the learning object
 - 1.7. **Keywords:** list of keywords describing the topic of the learning object
 - 1.8. **Coverage:** the time, culture, geography or region to which this learning object applies. The extent or scope of the content of the learning object. Coverage will typically include spatial location (a place name or geographic coordinates), temporal period (a period label, date, or date range) or jurisdiction (such as a named administrative entity). Specify "Not available" if needed
2. **Life Cycle:** the category describes the history and current state of the learning object and those entities that have affected the learning object during its evolution
 - 2.1. **Version:** the edition of the learning object. Example: 1.2. Specify "Not available" if needed

⁵ IEEE Standard for LOM https://standards.ieee.org/standard/1484_12_1-2002.html

- 2.2. **Status:** the completion status or condition of the learning object. It can be Draft, Final, Revised, Unavailable
- 2.3. **Contribute:** those Entities (i.e., people, organizations) that have contributed to the state of the learning object during its life cycle (e.g., creation, edits, publication)
 - 2.3.1. **Role:** kind of contribution. It can be author, publisher, unknown, initiator, terminator, validator, editor, graphical, designer, technical implementer, content, provider, technical validator, educational validator, script writer, instructional designer, subject matter expert
 - 2.3.2. **Entity:** the identification of and information about entities (i.e., people, organizations) contributing to the learning object (e.g., FOAF: Friend Of A Friend)
- 2.4. **Date:** the date of the contribution. Specify "Not available" if needed.
- 3. **Educational:** this category describes the key educational or pedagogic characteristics of the learning object
 - 3.1. **Interactivity type:** predominant mode of learning supported by the learning project. It can be active, expositive, mixed. "Active" learning (e.g., learning by doing) is supported by content that directly induces productive action by the learner. An active learning object prompts the learner for semantically meaningful input or for some other kind of productive action or decision, not necessarily performed within the learning object's framework. Active documents include simulations, questionnaires, and exercises. "Expositive" learning (e.g., passive learning) occurs when the learner's job mainly consists of absorbing the content exposed to him (generally through text, images or sound). An expositive learning object displays information but does not prompt the learner for any semantically meaningful input. Expositive documents include essays, video clips, all kinds of graphical material, and hypertext documents. When a learning object blends the active and expositive interactivity types, then its interactivity type is "mixed."
 - 3.2. **Learning resource type:** specific kind of learning object. It can be exercise, simulation, questionnaire, diagram, FAQs (Frequently Asked Questions), figure, graph, index, slide, table, narrative text, exam, experiment, problem statement, self-assessment, lecture, video, webinar
 - 3.3. **Interactivity level:** the degree of interactivity characterizing the learning object. Interactivity in this context refers to the degree to which the learner can influence the aspect or behaviour of the learning object. It can be very low, low, medium, high, very high
 - 3.4. **Semantic density:** the degree of conciseness of the learning object. The semantic density of a learning object may be estimated in terms of its size, span, or - in the case of self-timed resources such as audio or video - duration. It can be very low, low, medium, high, very high
 - 3.5. **Intended end user role:** principal user(s) for which the learning object was designed, most dominant first. It can be Teacher, Author, Learner, Manager.

- 3.6. **Context:** the principal environment within which the learning and use of the learning object is intended to take place. It can be school, higher education, training, other
 - 3.7. **Difficulty:** how hard it is to work with or through the learning object for the typical intended target audience. It can be: very easy, easy, medium, difficult, very difficult, knowledge-dependent
 - 3.8. **Typical learning time:** approximate or typical time it takes to work with or through the learning object for the typical intended target audience. Example: PT1H30M, which means 1 hour and 30 minutes; PT1M45S, which means 1 minute and 45 seconds. Specify "Knowledge-dependent" if the learning time depends on the familiarity with the context
 - 3.9. **Rights:** describes the intellectual property rights and conditions of use for the learning object. Example: Copyright © 2018 xxx. Specify "Not available" if needed
 - 3.10. **Cost:** whether use of the learning object requires payment (Yes/No)
 - 3.11. **Copyright and other restrictions:** whether copyright or other restrictions apply to the use of the learning object (Yes/No)
 - 3.12. **Condition of use:** comments on the conditions of use of the learning object (e.g., Free access)
4. **Technical:** this category describes the technical requirements and characteristics of the learning object
- 4.1. **Location:** a string that is used to access the learning object. It may be a location (e.g., Universal Resource Locator), or a method that resolves to a location (e.g., Universal Resource Identifier). The first element of this list shall be the preferable location. Specify "Not available" if needed
 - 4.2. **Size:** the size of the digital learning object in bytes not Mbytes, GB, etc. This data element shall refer to the actual size of this learning object. If the learning object is compressed, then this data element shall refer to the uncompressed size. Specify "Not available" if needed.
 - 4.3. **Topic codes:** customised metadata, the code and title of the topic covered according to the list of training topic identified in Table 1 of the deliverable 6.1. Topic codes are mainly divided into two subject categories: “general FAIR-related” (from G1 to G7) and “research data management-related” (from R1 to R17).

A more detailed table containing the considered LOM elements can be found in Appendix B.

2.2 Goals and Stakeholders

The training catalogue manages four types of users:

- Guest user: lowest permission level, she/he can only access the public area and view/access the resources of the catalogue;
- Registered user: medium permission level, she/he can modify his own profile data and comment/evaluate the usefulness and effectiveness of a resource;

- Contributor: intermediate permission level, she/he can create and manage new Learning Objects. A registered user can become a contributor by contacting the administrator that will be in charge to evaluate the request and change the role;
- Administrator: highest permission level, she/he can access the admin area and perform every function (e.g., full management of Learning Objects, users, metadata profiles, etc.).

A very simple registration form and login form have been developed (Figure 2).

Figure 2. ENVRI-FAIR Training Catalogue home page - <https://trainingcatalogue.envri.eu>

2.3 Implemented features

The implemented catalogue:

- is an open-source solution;
- is accessible on all platforms;
- allows to search services both via user interface and via RESTful interface (that is by means of APIs)

The main features of the catalogue are related to the type of user:

- the user is able to:
 - access metadata of resources in which he/she is interested in;
 - access the actual training resource and hence start the training (by using the “Start the course” button);
 - add/update resource with descriptive metadata into the catalogue;
 - request resource to be deleted (with a specific reason and after the administrative approval);
 - search resources based on metadata elements (simple + advanced search);
 - leave feedback (5 stars ratings) and comments for a specific resource.
- the administrator is able to:

- perform all functionalities allowed by the user;
- manage registered users and roles;
- approve metadata for a specific resource once metadata are added by a user;
- delete metadata for a specific resource if needed or requested by a user;
- moderate comments obtained from users.

In Figure 3, an example detail page is shown. After the title and an image representing the training resource, the left side of the page contains all the metadata divided into sections. The right side of the page contains instead the “Start the course” button that allows to directly point and access to the training material and the technical details about the publisher, the date, etc.

The screenshot shows the detail page for a training resource titled "Data and the FAIR Principles". The page layout includes a header with the ENVRI logo and a "Login" button. Below the title is a large image of people working at a computer. The main content area is divided into two columns. The left column contains a "Description" section followed by a metadata table. The right column contains a "Start the course" button (circled in red) and a "Details" section with technical information. Annotations with blue arrows point to the "Start the course" button, the metadata table, and the text "Start the training course".

Start the training course

Technical details

Metadata set divided into sections

1 - General	
1.1 - Identifier	003
1.2 - Catalog	URL
1.3 - Entry	http://www.repronim.org/module-FAIR-data/
1.4 - Title	Data and the FAIR Principles
1.5 - Language	en
1.6 - Description	This module provides five lessons to ensure that a researcher's data is properly managed and published to ensure it enables reproducible research.
1.7 - Keywords	fair data; fair principles
1.9 - Coverage	2016
2 - Life Cycle	
2.1 - Version	Not available
2.2 - Status	Final
2.3 - Contribute	
2.3.1 - Role	Technical validator
2.3.2 - Entity	FOAF
2.4 - Date	2016
3 - Educational	
3.1 - Interactivity type	Expositive
3.2 - Learning resource type	Lecture

Figure 3. ENVRI-FAIR Training Catalogue home page - <https://trainingcatalogue.envri.eu>

2.3.1 REST APIs

An API is a set of functions that allows applications to access data and interact with external software components, operating systems, or microservices. The APIs available in the training catalogue and listed below can be used for harvesting and querying purposes by other catalogues/applications or with a browser.

The GET and POST methods are two of the most common HTTP methods.

The GET method is used to request data from a specified resource, this means that it is not used to modify data. GET requests can be cached, remain in the browser history, have specific length restrictions and should never be used when dealing with sensitive data since are easier to hack for script kiddies.

The POST method is used to send data to a server in order to create/update a resource. Differently from the GET requests, POST requests are never cached, do not remain in the browser history and have no restrictions on data length.

Synthetic List

<https://trainingcatalogue.envri.eu/api/list?format={json/xml}>

This API is a GET method and returns some fields (external_id, code, title, subtitle, description) of all active resources loaded into the catalogue. The input parameter format is optional and it permits to obtain the response as xml, if format = xml, or as json, if format =json. If format parameter is not used, the default response format is json.

Examples:

<https://trainingcatalogue.envri.eu/api/list?>

<https://trainingcatalogue.envri.eu/api/list?format=xml>

<https://trainingcatalogue.envri.eu/api/list?format=json>

Detailed List

<https://trainingcatalogue.envri.eu/api/full-list?format={json/xml}>

This API is a GET method and returns the list of all active resources loaded into the catalogue, as the previous one, plus it also returns the fields of LOM. The input parameter format is optional and permits to obtain the response as xml, if format = xml, or as json, if format =json. If format parameter is not used, the default response format is json.

Examples:

<https://trainingcatalogue.envri.eu/api/full-list?>

<https://trainingcatalogue.envri.eu/api/full-list?format=xml>

<https://trainingcatalogue.envri.eu/api/full-list?format=json>

Single resource detail

https://trainingcatalogue.envri.eu/api/resource?extid={external_id}&format={json/xml}

This API is a GET method and returns all resource data, included LOM fields, that match the parameter external_id in input. The input parameter external_id is mandatory and is the unique id of required resource. The input parameter format is optional and permits to obtain the response as xml, if format = xml, or as json, if format =json. If format parameter is not used, the default response format is json.

Examples:

<https://trainingcatalogue.envri.eu/api/resource?extid=HTjETKz1aj>

<https://trainingcatalogue.envri.eu/api/resource?extid=HTjETKz1aj&format=xml>

<https://trainingcatalogue.envri.eu/api/resource?extid=HTjETKz1aj&format=json>

LOM definition

`https://trainingcatalogue.envri.eu/api/lom-structure?format={json/xml}`

This API is a GET method and returns the LOM structure at the time of the request. The input parameter format is optional and permits to obtain the response as xml, if format = xml, or as json, if format =json. If format parameter is not used, the default response format is json.

Examples:

<https://trainingcatalogue.envri.eu/api/lom-structure?>

<https://trainingcatalogue.envri.eu/api/lom-structure?format=xml>

<https://trainingcatalogue.envri.eu/api/lom-structure?format=json>

Simple search

`https://trainingcatalogue.envri.eu/api/search?format={json/xml}`

This API is a POST method and returns external_id, code, title, subtitle, description of those resources that matched the specified search parameters. The possible input parameters for post method are: code, title, subtitle, description, it is mandatory to enter at least one parameter.

This API can be tested using the site <https://reqbin.com/> or postman app. Select POST type of rest, insert the URL in the dedicated text area, then select Content and choose FORM URL Encoded (application/x-www-form-urlencoded) in the drop-down menu.

In the text area for parameters, you can write for example: code = 4 title=fairness

Advanced search

`https://trainingcatalogue.envri.eu/api/full-search?format={json/xml}`

This API is a POST method and returns all metadata of those resources that matched the specified search parameters. The possible input parameters for post method are: code, title, subtitle, description. It is mandatory to enter at least one parameter. This API can be tested using the site <https://reqbin.com/> or postman app. Select POST type of rest, insert the URL in the dedicated text area, then select Content and choose FORM URL Encoded (application/x-www-form-urlencoded) in the drop-down menu. In the text area for parameters you can write for example: code = 4 title=fairness metadata[1.5]=en metadata[1.1]=1

3 The Training Platform

3.1 Materials and methods

The ENVRI Common Training Platform hosts advanced and cutting-edge course materials and webinars, where appropriate, in close collaboration with RIs, making them available, deepening and extending or adapting existing materials, whenever possible. It represents the evolution of the training platform created in the ENVRIplus project.

The home page of the training platform, available at <https://training.envri.eu>, <https://trainingcatalogue.envri.eu> is shown in Figure 4.

The screenshot shows the home page of the ENVRI-FAIR Training Platform. At the top, there is the ENVRI community logo and navigation links: Home | ENVRI Community | Courses | Sign up | Log in. A search bar is located in the top right corner. The main banner features a photograph of a man pointing at a whiteboard with mathematical equations, overlaid with the text "Welcome to the ENVRI community Training platform" and a "Know More" button. Below the banner, there are four circular icons representing different features: Scientific Gaming, Tutorials, ENVRI Community, and Help-Desk. Each icon has a corresponding title and a brief description. The "Available courses" section displays a grid of course cards, each with a thumbnail image and a title. The "Navigation" sidebar on the right shows "Home" and "Courses" links. The "Calendar" sidebar shows the month of May 2021.

Figure 4. ENVRI-FAIR Training Platform home page - <https://training.envri.eu>

3.1.1 Identification of an appropriate LMS

The Training Platform is based on Moodle, a Learning Management System (LMS) that aims at giving teachers and students the tools they need to teach and learn. Moodle comes from a background of Social Constructionist pedagogy; however, it can be used to support any style of teaching and learning. There are other types of software systems that are important for educational institutions, for example ePortfolios, Student Information Systems and Content repositories. Generally, Moodle does not try to re-invent these areas of functionality. Instead, it interoperates gracefully with other systems that provide the other areas of functionality. This represents the main reason why we selected Moodle. Moodle is an open-source web application written in PHP. Copyright is owned by individual contributors, not assigned to a single entity, although the company Moodle Pty Ltd in Perth Australia, owned by Moodle's founder Martin Dougiamas, manages the project.

Like many successful open-source systems, Moodle is structured as an application core, surrounded by numerous plugins to provide specific functionalities. Moodle is designed to be highly extensible and customizable without modifying the core libraries, as doing so would create problems when upgrading Moodle to a newer version.

Plugins in Moodle are of specific types. That is, an authentication plugin and an activity module will communicate with Moodle core using different APIs, tailored to the type of functionality the plugin provides. Functionalities common to all plugins (installation, upgrade, permissions, configuration etc.) are, however, handled consistently across all plugin types. The standard Moodle distribution includes Moodle core and a number of plugins of each type, so that a new Moodle installation can immediately be used to start teaching and learning. After the installation, a Moodle site can be adapted for a particular purpose by changing the default configuration option, and by installing add-ons or removing standard plugins.

Moodle core provides the entire infrastructure necessary to build a LMS and implements the key concepts that all the different plugins will need to work with. These include:

- Courses and activities: a Moodle course is a sequence of activities and resources grouped into sections. Courses themselves are organized into a hierarchical set of categories within a Moodle site.
- Users: Moodle users are anyone who uses the Moodle system. In order to participate in a course, users need to be enrolled in that specific course with a given role, such as student or teacher.
- Course enrolment: enrolment gives user the possibility to participate in course as a student or teacher.
- User functionalities:
 - user roles: roles assigned to users give them a set of capabilities in given context. Examples of roles are Teacher, Student and Forum moderator.
 - user's capabilities: a capability is a description of some particular Moodle features. Capabilities are associated with roles.
 - context: a context is a "space" in Moodle, such as courses, activity modules, blocks etc.
 - permissions: a permission is a value that is assigned for a capability of a particular role. For example, allow or prevent.
- Additional facilities provided by Moodle:

- creation and editing of user profiles: in Moodle, when a user creates his account, a specific profile is created for her/him. The user needs to fill in her/his initial details for completing the profile that can be always edited after creation.
- groups and cohorts: cohorts, or site-wide groups, enable all members of a cohort to be enrolled in a course in one action, either manually or synchronised automatically.
- enrolments and access control: users are generally enrolled into some courses and according to their permission settings and the groups to which they belong they have limited access on Moodle.

4 Developing FAIR Training Materials

4.1 Introduction

The development and cataloguing of FAIR training materials and their required metadata started in December 2019. In 2 years, 42 educational resources have been developed employing FAIR best practices and principles and then hosted on the ENVRI training catalogue.

The developed resources aim at responding to a wide spectrum of different learning needs and thus present specific structures, implement a variety of methodological approaches, and imply different interactivity levels.

4.2 Material and methods

With reference to the structures, the training activities have been organized in the forms of one-day training events, short (few days) training courses, as well as one-week courses denominated Summer/Winter Schools. Depending on the specific topic, these training programmes have been delivered as webinars, workshops, practical exercises and self-paced training courses. Finally, the established learning objectives and their respective complexity, determined interactivity levels that extend from low in the case of webinars to very high as requested for the hands-on practical exercises.

This implies that the development of the training material strictly depends on the material itself and it requires a given procedural path to be followed for its production in relation to its nature.

4.3 A concrete example: the ENVRI Community International Winter School on DATA FAIRness

For sake of clarity and example, let consider the last ENVRI Community International Winter School on data FAIRness that run online from January 11th to 22nd and attracted 32 participants from all around the world, predominantly data centre staff, researchers and PhD candidates.

The creation of the training course in the training platform started some weeks before the event itself. In particular, as soon as we defined the programme with the corresponding teachers/speakers, the skeleton of the course has been created (one section for each day of the school). After that, the (potential) preparatory/reading material was added for each section of the school.

The course on the Moodle platform remained in a draft mode until the first day of the event, when all the needed materials and information were published so that students can freely access to them.

The course is visible in the home page of the platform in the “Available courses” section with an appropriate icon and text (see Figure 5).

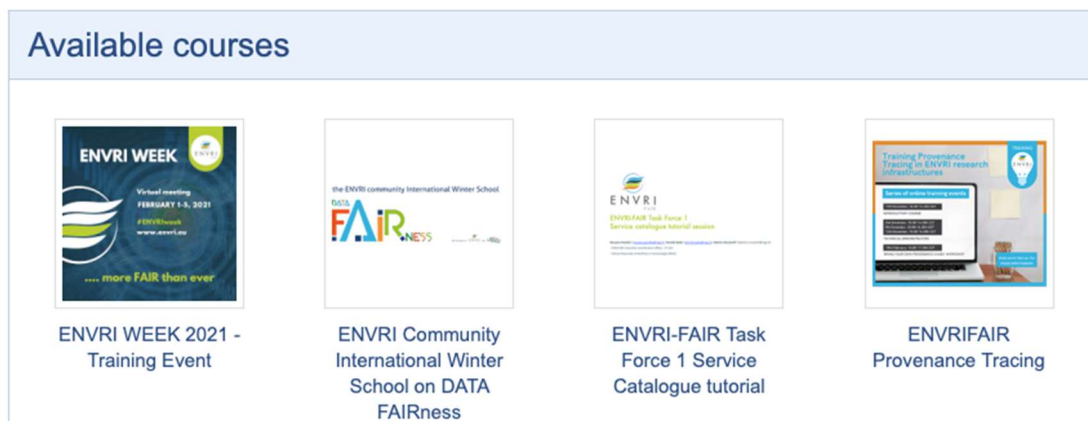


Figure 5. Available courses published on the ENVRI Training Platform

The template of the training course detail page has been created in order to have a single section for each day/topic of the school. See <https://training.envri.eu/course/view.php?id=52>.

In recognition of the difficulties of distance learning, we structured 40 hours of presence (including preparations) over a two-week period, with scheduled lectures and presentations in the mornings (09-11), followed by associated group and individual work time (11-12).

During the first day of lecture, Dr Antonio José Saenz-Albanes (ICT Infrastructure Operations Coordinator at LifeWatch ERIC) and Dr José Maria Garcia-Rodriguez (Associate Professor of Applied Software Engineering at the University of Seville) dealt with how semantics enrich data resources and increase their FINDability by making them machine-actionable. In the second day of the first week, Dr Ute Karstens and Dr Claudio Onofrio, respectively researcher and data scientist at Lund University, Sweden, gave a presentation on a fully integrated VRE application at ICOS Carbon Portal, called the atmospheric transport model STILT, running through a full life cycle for an 'on demand' model and visualising results as an interactive map; Dr Karolina Pantazatou and Ida Storm also work at ICOS Carbon Portal, Lund University, as scientific programmer and project assistant and hosted an highly appreciated workshop on using GIS-tools, Python-programming and user friendly Jupyter notebooks that process and analyse ICOS data products.

Figure 6 shows how these two sections/topics look like in the training platform.




Semantics

Tuesday January 12, 09:00-11:00 CET




Teachers: Antonio José Sáenz-Albanés & José María García-Rodríguez



In this session you will learn basic concepts about semantics and how it can enrich your data resources and increase its FAIRness, turning it into machine-actionable data that can be effectively discovered and accessed by interested parties. We will also consider additional aspects to foster the discoverability of data resources, such as security and relevant software tools.

-  Semantics - Part 1 31.9MB
-  Semantics - Part 2 3.1MB
-  Semantics session recording


Preparatory readings/materials

-  Ontology Development 101: A Guide to Creating Your First Ontology
-  Linked Open Vocabularies (search and aggregator of LD vocabs)
-  Semantic Web Tutorial Slides



VREs, Data Analysis & Visualisation

Wednesday January 13, 09:00-11:00 CET

Teachers: Ute Karstens, Claudio D'Onofrio, Karolina Pantazatou, Ida Storm



A short presentation is given on a fully integrated web application at ICOS Carbon Portal, on the example of the atmospheric transport model STILT. We will run through a full life cycle for an 'on demand' model run and results visualisation. Further on we will show case how to use the results to create a new data product. A hands-on workshop follows to create a simple timeseries plot comparing STILT results with observational data and creating an interactive map for the station location.

-  VREs, Data Analysis & Visualisation 4.4MB
-  VREs, Data Analysis & Visualisation Session recording

Preparatory readings/materials

P.S. Preferred browsers for exploring data: Firefox, Chrome


-  Introduction to Jupyter - webinar Sept. 2020
-  ICOS Jupyter documentation
-  STILT Footprint Tool
-  ICOS Open Jupyter service

Figure 6. First week of the Winter School - sections of the training course in Moodle

The informatic engineers of the LifeWatch ERIC Service Centre in Lecce, Italy, Nicola Fiore and Lucia Vaira kicked off the second week with a presentation on the LifeWatch ERIC Metadata Catalogue, explaining the entire process behind the creation and publication of new resources and how to access them.

Finally, Dr Zhiming Zhao, assistant professor at the University of Amsterdam, used examples from the ENVRIplus and ENVRI-FAIR projects to illustrate how to develop and operate data management services in cloud environments to automating their deployment. Students were able to practice on the cloud infrastructures at EOSC and LifeWatch.

Figure 7 shows how these two sections/topics look like in the training platform.



Resource access tools

Monday January 18, 09:00-11:00 CET

Teachers: *Nicola Fiore & Lucia Vaira*



A short presentation will be given on the LifeWatch ERIC Metadata Catalogue in order to show how resources (datasets, services, workflows, etc.) can be published on a catalogue. In particular, we will go through the entire process behind the resource publication and we will show how to create/publish/access new resources. A breakout room will follow the lecture to let students creating their own resources.

-  Resource Access Tools 11.6MB
-  Resource access tools Session recording

Cloud computing for developing and operating data management services

Tuesday January 19, 09:00-11:00 CET

Teacher: *Zhiming Zhao*



We will discuss how to develop and operate data management services in cloud environments. By using examples from the ENVRiplus and ENVRi-FAIR projects, we will demonstrate the basic steps to run a legacy application in cloud, to develop native cloud applications, to automate the application deployment, and to auto-scale a runtime application. Students will practice on the cloud infrastructures offered by providers such as EOSC or LifeWatch.

-  Cloud computing 13MB
-  Cloud Computing Session recording

Preparatory readings/materials

Students are recommended to read the ENVRi book, chapter 2, 5 and 11

-  ENVRi Book





Figure 7. Second week of the Winter School - sections of the training course in Moodle

Besides the traditional training material, Moodle also allows to include in a given training course feedback forms, that are very important to improve the quality and relevance of the future training events. Indeed, in the last day of the school, after the participants presentation and the closing session, attendees were asked to fill in the feedback form (Figure 8)

Participants' presentations and closing session -

Friday, Jan. 22

The final **report** and the corresponding ppt **presentation** have to be sent **within Thursday January 21st** by email to lucia.vaira@lifewatch.eu.

-  Guidelines for the final presentation 42.7KB
-  Agenda for presentations
-  Closing session 5.2MB
-  Closing Session Recording

Your Feedback on the ENVRi Community International Winter School DATA FAIRness

We would like to ask you to give us some feedback, your responses will help us improve the quality and relevance of our future events. The questionnaire is anonymous, and no personal data is recorded about the participants.

Thank you in advance for your time,

The ENVRi-FAIR WP6 core team

-  ENVRi winter school - Feedback

Figure 8. Last day of the Winter School - sections of the training course in Moodle

One of the post-event activities associated to a training event is the creation of a metadata record for that specific event. For the winter school, the metadata have been collected and published in the training catalogue (see Figure 9) some days after the event (see <https://trainingcatalogue.envri.eu/course/47>).

The screenshot shows the top navigation bar with the ENVRI community logo on the left and 'Home About APIs Contact us' on the right. The main heading reads 'ENVRI Community International Winter School on data FAIRness' followed by 'the ENVRI community International Winter School'. Below this is a large 'DATA FAIRNESS' logo. To the right, there are logos for 'With the support of ENVRI and LifeWatch ERIC'. A 'Start the course' button is visible on the right side. On the left, there is a 'Description' section with the following text:

Description

The 2021 ENVRI Community International Winter School from January 11-22 attracted 32 participants from all around the world, predominantly data centre staff, researchers and PhD candidates. Centred on the FAIR principles of data management, the online curriculum covered semantic navigation, Jupyter environments for visualisation and data discovery, resource access tools and cloud computing. In recognition of the difficulties of distance learning, the organisers structured 40 hours of presence (including preparations) over a two-week period, with scheduled lectures and presentations in the mornings (09-11), followed by associated group and individual work time (11-12). The relevance of the content to the participants' work ensured a high level of commitment and a great sense of camaraderie developed. FAIR data are data which meet the principles of findability, accessibility, interoperability and reusability. The presentation of real-life use cases using state-of-the-art technologies demonstrated how essential it is to support end users in making the best use of the data, and to develop good user interfaces and services. The time the participants spent together created a new knowledge-exchange network for these data professionals. The team of teachers behind the "ENVRI-FAIR Resources: Access & Discoverability" Winter School was also international, with up-to-the-minute experience in the application of new technologies to enhance data centre functionality.

On the right side, there is a 'Details' table:

Details	
Code	044
Uploaded by	Lucia Vaira
Available since	27/01/21 14:05

Figure 9. ENVRI-FAIR Training Catalogue home page - <https://trainingcatalogue.envri.eu>

The “Start the course” button on the right side of the page allows to directly points and access the course materials in the training platform. Figure 10 shows this integration/interconnection.

ENVRI
Training Catalogue

The screenshot shows the course page in the training catalogue. The course title is "the ENVRI community International Winter School on data FAIRness". Below the title is a description of the course, which includes details about the 2021 edition, the curriculum, and the teaching team. A red circle highlights the "Start the course" button, which is located in the top right corner of the course details section.

<https://trainingcatalogue.envri.eu/course/47>

ENVRI
Training Platform

The screenshot shows the course page in the training platform. The course title is "the ENVRI community International Winter School on data FAIRness". The page layout includes a navigation menu on the left, a main content area with a course overview, and a right-hand sidebar with search forums, latest news, upcoming events, and recent activity. The course details are more comprehensive than in the catalogue, including a list of participants and a detailed schedule of sessions.

<https://training.envri.eu/course/view.php?id=52>

Figure 10. Interconnection between the Training Catalogue and the Training Platform

5 Collaborations with other projects and initiatives

The ENVRI-FAIR Training Catalogue attracted several members of various initiatives and projects. Indeed, its mature status and user-friendly interface allowed us to present it in different occasions as a successful case study.

FAIRsFAIR (Fostering Fair Data Practices in Europe) project⁶

In a 36 months time range, the FAIRsFAIR project addresses the development and concrete realization of an overall knowledge infrastructure on academic quality data management, procedures, standards, metrics and related matters, based on the FAIR principles. FAIRsFAIR released a first set of preliminary recommendations for FAIR Semantic artefacts⁷ that includes 17 General recommendations and 10 Best Practices recommendations, with a very special focus on metadata. On October 29 2020, in conjunction with EOSC-5B Projects Training and Skills Task Force, FAIRsFAIR organized a workshop on "Training Resource Catalogue Interoperability". Since both FAIRsFAIR and the EOSC 5B projects have a shared interest in making training resources FAIR, and many of the projects are developing catalogues of training resource, the workshop aimed to bring together interested parties to discuss and share approaches, challenges and identify common goals.

We were invited to present the ENVRI-FAIR Training Catalogue and our methodology in order to show how to publicly offer an accessible training resource catalogue with the final aim to make the metadata harvestable and FAIR, using specific standards and harvesting/publishing mechanisms. We showed and described the main features and functionalities of the training catalogue, the aspects related to the user management, and the metadata schema adopted for the learning objects.

Research Data Alliance Working Group

Since the beginning of the ENVRI-FAIR project, we are collaborating with the "Education and Training on handling of research data Interest Group"⁸. In particular, we are part of the Focus Group "Minimal Metadata for Training Resources" which meets every 2 weeks on Tuesday with the aim to collaboratively work on recommendations for a minimal set of metadata for learning resources. By comparing and analysing metadata schemes related to existing learning resources to find the overlaps, the group intends to provide guidance on metadata elements that should be minimally required for purposes of learning resource discovery to those concerned with supporting or providing training resources. We are providing our experience, our expertise and our training catalogue as use case, in order to identify and recommend a set of minimal metadata elements in a format that will allow ease in re-use.

Open AIRE Community of Practice for Training Coordinators (CoP)

The Open AIRE Community of Practice for Training Coordinators⁹ is an informal network of people who coordinate training programmes implemented in more than 30 different research institutes and e-infrastructures. This Community of Practice maps out the training activities of various pan-European, EOSC-related initiatives strengthening their training capacity by sharing experiences and good practices.

⁶ FAIRsFAIR project homepage: <https://www.fairsfair.eu>

⁷ Preliminary recommendations for FAIR Semantic artefacts: <https://doi.org/10.5281/zenodo.3707984>

⁸ Education and Training on handling of research data Interest Group: <https://rd-alliance.org/groups/education-and-training-handling-research-data.html>

⁹ Open AIRE Community of Practice for Training Coordinators: <https://www.openaire.eu/cop-training>

The CoP was launched on September 2018 and holds a monthly meeting since then. LifeWatch ERIC participates to the meetings since the beginning and contributes sharing news about training related topics and its new training activities and products.

With reference to this specific Deliverable D6.2, LifeWatch ERIC, during the design, and the subsequent development phase, of both the Training Catalogue and all the various Training Resources, presented, discussed, cross-checked, and validated with this network the potential approaches, topics and learning products. The inputs and comments received from the CoP colleagues proved extremely valuable and effective to define and implement the final products.

6 Appendix A: Glossary and terminology

NOTE: The latest version of the master list of the glossary is available at <https://zenodo.org/record/4471374#.YM-4I2gzY2w>.

The following is a list of acronyms and terms used in this deliverable:

API	Application Program Interface
COP	Community of Practice for Training Coordinators
CTP	Community Training Platform
Data Centre	a large group of networked computer servers typically used by organizations for the remote storage, processing, or distribution of large amounts of data
ENVRI Community	Environmental Research Infrastructures community
ENVRIplus	Cluster Project for the ENVRI community 2015-2019
ENVRIIs	Environmental Research Infrastructures
EPOS	European Plate Observing System
FAIR	Findable, Accessible, Interoperable and Reusable
FOAF	Friend Of A Friend
IEEE	Institute of Electrical and Electronic Engineers
LMS	Learning Management System
LOM	Learning Object Metadata
RDA	Research Data Alliance
REST	REpresentational State Transfer
RI	Research Infrastructure
Webinar	a seminar conducted over the Internet
WP	work package

7 Appendix B: LOM elements in the Training Catalogue

Name	Explanation	ValueSpace	Datatype	Example
1. General	This category groups the general information that describes this learning object as a whole.			
1.1. Identifier	A globally unique label that identifies this learning object.			
1.2. Catalog	The name or designator of the identification or cataloguing scheme for this entry. A namespace scheme.	Repertoire of ISO/IEC 10646-1:200	CharacterString (smallest permitted maximum: 1000 char)	URI
1.3. Entry	The value of the identifier within the identification or cataloguing scheme that designates or identifies this learning object. A namespace specific string.	Repertoire of ISO/IEC 10646-1:200	CharacterString (smallest permitted maximum: 1000 char)	"http://www.ieee.org/documents/1234"
1.4. Title	Name given to this learning object		LangString (smallest permitted maximum: 1000 char)	("en," "The life and works of Leonardo da Vinci")
1.5. Language	The primary human language or languages used within this learning object to communicate to the intended user. NOTES 1. An indexation or cataloguing tool may provide a useful default. 2. If the learning object had no lingual content (as in the case of a picture of the Mona Lisa, for example), then the appropriate value for this data element would be "none."	LanguageID = Langcode ("-"Subcode)* with Langcode a language code as defined by the code set ISO 639:1988 and Subcode (which can occur an arbitrary number of times) a country code from the code set ISO 3166-1:1997.NOTES1— This value space is also defined by RFC1766:1995 and is harmonized with that of the xml:lang attribute.2—ISO 639:1988 also includes "ancient" languages, like Greek and Latin.	CharacterString (smallest permitted maximum: 100 char)	"en" "en-GB" "de" "fr-CA" "it"

Name	Explanation	ValueSpace	Datatype	Example
		The language code should be given in lower case and the country code (if any) in upper case. However, the values are case insensitive. "none" shall also be an acceptable value.		
1.6. Description	A textual description of the content of this learning object. NOTE: this description need not be in language and terms appropriate for the users of the learning object being described. The description should be in language and terms appropriate for those that decide whether the learning object being described is appropriate and relevant for the users.		LangString (smallest permitted maximum: 2000 char)	("en," "In this video clip, the life and works of Leonardo da Vinci are briefly presented. The focus is on his artistic production, most notably the Mona Lisa.")
1.7. Keywords	A keyword or phrase describing the topic of this learning object. This data element should not be used for characteristics that can be described by other data elements.		LangString (smallest permitted maximum: 1000 char)	("en," "Mona Lisa")
1.8. Coverage	The time, culture, geography or region to which this learning object applies. The extent or scope of the content of the learning object. Coverage will typically include spatial location (a place name or geographic coordinates), temporal period (a period label, date, or date range) or jurisdiction (such as a named administrative entity). Recommended best practice is to select a value from a con-		LangString(smallest permitted maximum: 1000 char)	("en," "16th century France") NOTE —A learning object could be about farming in 16th century France: in that case, its subject can be described with 1.5:General.Key-word=("en," "farming") and its 1.6:General.Coverage can be ("en,"

Name	Explanation	ValueSpace	Datatype	Example
	<p>controlled vocabulary (for example, the Thesaurus of Geographic Names [TGN]) and that, where appropriate, named places or time periods be used in preference to numeric identifiers such as sets of coordinates or date ranges.</p> <p>NOTE —This is the definition from the Dublin Core Metadata Element Set, version 1.1 [B1].(http://www.dublincore.org/documents/dces/)</p>			“16th century France”).
2. Life Cycle	The category describes the history and current state of this learning object and those entities that have affected this learning object during its evolution.			
2.1. Version	The edition of this learning object.		LangString (smallest permitted maximum: 50 char)	(“en,” “1.2.alpha”), (“nl,” “voorlopige versie”)
2.2. Status	The completion status or condition of this learning object.	<p>Draft Final Revised Unavailable</p> <p>NOTE—When the status is “unavailable” it means that the learning object itself is not available.</p>	Vocabulary (State)	
2.3. Contribute	<p>Those Entities (i.e., people, organizations) that have contributed to the state of this learning object during its life cycle (e.g., creation, edits, publication).</p> <p>NOTE: contributions should be considered in a very broad</p>			

Name	Explanation	ValueSpace	Datatype	Example
	sense here, as all actions that affect the state of the learning object.			
2.3.1. Role	Kind of contribution. NOTE —Minimally, the Author(s) of the learning object should be described	<ul style="list-style-type: none"> • Author • Publisher • Unknown • initiator • terminator • validator • editor • graphical designer • technical implementer • content provider • technical validator • educational validator • script writer • instructional designer • subject matter expert NOTE: “terminator” is the entity that made the learning object unavailable.	Vocabulary (State)	
2.3.2. Entity	The identification of and information about entities (i.e., people, organizations) contributing to this learning object. The entities shall be ordered as most relevant first.	FOAF	Vocabulary (State)	
2.4. Date	The date of the contribution.		DateTime	“2001-08-23”
3. Educational	This category describes the key educational or pedagogic characteristics of this learning object. NOTE—This is the pedagogical information essential to those involved in achieving a quality			

Name	Explanation	ValueSpace	Datatype	Example
	learning experience. The audience for this metadata includes teachers, managers, authors, and learners.			
3.1. Interactivity type	<p>Predominant mode of learning supported by this learning project.</p> <p>“Active” learning (e.g., learning by doing) is supported by content that directly induces productive action by the learner. An active learning object prompts the learner for semantically meaningful input or for some other kind of productive action or decision, not necessarily performed within the learning object's framework. Active documents include simulations, questionnaires, and exercises.</p> <p>“Expositive” learning (e.g., passive learning) occurs when the learner's job mainly consists of absorbing the content exposed to him (generally through text, images or sound). An expositive learning object displays information but does not prompt the learner for any semantically meaningful input. Expositive documents include essays, video clips, all kinds of graphical material, and hypertext documents. When a learning object blends the active and expositive interactivity types, then its interactivity type is “mixed.”</p> <p>NOTE—Activating links to navigate in hyper-text documents is not considered to be a productive action.</p>	<ul style="list-style-type: none"> • Active • Expositive • Mixed 	Vocabulary (State)	<p>active documents (with learner's action):</p> <ul style="list-style-type: none"> • simulation (manipulates, controls or enters data or parameters); • questionnaire (chooses or writes answers); • exercise (finds solution); • problem statement (writes solution). • expositive documents (with learner's action): • hypertext document (reads, navigates); • video (views, rewinds, starts, stops); • graphical material (views); • audio material (listens, rewinds, starts, stops). <p>mixed document:</p> <ul style="list-style-type: none"> • hypermedia document with embedded simulation applet.

Name	Explanation	ValueSpace	Datatype	Example
3.2. Learning resource type	<p>Specific kind of learning object. The most dominant kind shall be first.</p> <p>NOTE—The vocabulary terms are defined as in the OED:1989 and as used by educational communities of practice.</p>	<ul style="list-style-type: none"> • Exercise • simulation • questionnaire • diagram • figure • graph • index • slide • table • narrative text • exam • experiment • problem statement • self-assessment • lecture 	Vocabulary (State)	
3.3. Interactivity Level	<p>The degree of interactivity characterizing this learning object. Interactivity in this context refers to the degree to which the learner can influence the aspect or behaviour of the learning object.</p> <p>NOTE—Inherently, this scale is meaningful within the context of a community of practice.</p>	<ul style="list-style-type: none"> • Very low • Low • Medium • High • very high 	Vocabulary (Enumerated)	<p>NOTE—Learning objects with 5.1:Educational.Int eractivity-Type="active" may have a high interactivity level (e.g., a simulation environment endowed with many controls) or a low interactivity level (e.g., a written set of instructions that solicit an activity). Learning objects with 5.1:Educational.Int eractivity-Type="expositive" may have a low interactivity level (e.g., a piece of linear, narrative text produced with a standard word processor) or a medium to high interactivity level (e.g., a sophisticated</p>

Name	Explanation	ValueSpace	Datatype	Example
				hyperdocument, with many internal links and views)
3.4. Semantic density	<p>The degree of conciseness of a learning object. The semantic density of a learning object may be estimated in terms of its size, span, or - in the case of self-timed resources such as audio or video - duration.</p> <p>The semantic density of a learning object is independent of its difficulty. It is best illustrated with examples of expositive material, although it can be used with active resources as well.</p> <p>NOTE—Inherently, this scale is meaningful within the context of a community of practice.</p>	<ul style="list-style-type: none"> • Very low • Low • Medium • High • very high 	Vocabulary (Enumerated)	<p><u>Active documents</u> (user interface of a simulation):</p> <p>a) low semantic density: a screen filled up with explanatory text, a picture of a combustion engine, and a single button labelled “Click here to continue”</p> <p>b) high semantic density: screen with short text, same picture, and three buttons labelled “Change compression ratio,” “Change octane index,” “Change ignition point advance”</p> <p><u>Expositive documents:</u></p> <p>a) medium difficulty text document</p> <p>1) medium semantic density: “The class of Marsupial animals comprises a number of relatively primitive mammals. They are endowed with a short placentation, after which they give birth to a larva. The larva thereafter takes refuge in the mother’s marsupium, where it settles to finish its</p>

Name	Explanation	ValueSpace	Datatype	Example
				<p>complete development.”</p> <p>2) high semantic density: “Marsupials are primitive mammals, with short placentation followed by the birth of larva, which thereafter takes refuge in the marsupium to finish its development.”</p> <p>b) easy video document</p> <p>1) low semantic density: The full recorded footage of a conversation between two experts on the differences between Asian and African elephants; 30 min duration.</p> <p>2) high semantic density: An expertly edited abstract of the same conversation; 5 min duration.</p> <p>c) difficult mathematical notation</p> <p>1) medium semantic density: The text representation of the theorem: For any given set ϕ, it is always possible to define another set ψ, which is a superset of ϕ.</p> <p>2) very high semantic density: The symbolic</p>

Name	Explanation	ValueSpace	Datatype	Example
				representation (formula) of the theorem ($\forall\phi \exists\psi: \psi \supset \phi$)
3.5. Intended end user role	<p>Principal user(s) for which this learning object was designed, most dominant first.</p> <p>NOTES</p> <p>1. A learner works with a learning object in order to learn something. An author creates or publishes a learning object. A manager manages the delivery of this learning object, e.g., a university or college. The document for a manager is typically a curriculum.</p> <p>2. In order to describe the intended end user role through the skills the user is intended to master, or the tasks he or she is intended to be able to accomplish, the category.</p>	<ul style="list-style-type: none"> • Teacher • Author • Learner • Manager 	Vocabulary (State)	An authoring tool that produces pedagogical material is a typical example of a learning object whose intended end user is an author.
3.6. Context	<p>The principal environment within which the learning and use of this learning object is intended to take place.</p> <p>NOTE: suggested good practice is to use one of the values of the value space and to use an additional instance of this data element for further refinement, as in (“LOMv1.0,” “higher education”) and (“http://www.ond.vlaanderen.be/onderwijs-invlaanderen/Default.htm,” “kan-didatuursonderwijs”)</p>	<ul style="list-style-type: none"> • School • higher education • training • other 	Vocabulary (State)	
3.7. Difficulty	How hard it is to work with or through this learning object for the typical intended target audience.	<ul style="list-style-type: none"> • very easy • easy • medium • difficult • very difficult 	Vocabulary (Enumerated)	

Name	Explanation	ValueSpace	Datatype	Example
3.8. Typical learning time	Approximate or typical time it takes to work with or through this learning object for the typical intended target audience.		Duration	"PT1H30M," "PT1M45S"
3.9. Rights	This category describes the intellectual property rights and conditions of use for this learning object. NOTE: the intent is to reuse results of ongoing work in the Intellectual Property Rights and e-commerce communities. This category currently provides the absolute minimum level of detail only.			
3.10. Cost	Whether use of this learning object requires payment.	Yes No	Vocabulary (State)	
3.11. Copyright and other restrictions	Whether copyright or other restrictions apply to the use of this learning object.	Yes No	Vocabulary (State)	
3.12. Conditions of use	Comments on the conditions of use of this learning object.		LangString (smallest permitted maximum: 1000 char)	("en," "Use of this learning object is only permitted after a donation has been made to Amnesty International.")
4. Technical	This category describes the technical requirements and characteristics of this learning object.			
4.1. Location	A string that is used to access this learning object. It may be a location (e.g., Universal Resource Locator), or a method that resolves to a location (e.g., Universal Resource Identifier). The first element of this list shall be the preferable location. NOTE: this is where the learning object described by this metadata instance is physically located.	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	"http://host/id"

Name	Explanation	ValueSpace	Datatype	Example
4.2. Size	The size of the digital learning object in bytes (octets). The size is represented as a decimal value (radix 10). Consequently, only the digits "0" through "9" should be used. The unit is bytes, not Mbytes, GB, etc. This data element shall refer to the actual size of this learning object. If the learning object is compressed, then this data element shall refer to the uncompressed size.	ISO/IEC 646:1991, but only the dig-its "0".."9"	CharacterString (smallest permitted maximum: 30 char)	4200