EOSC Future

D9.2

EOSC Knowledge Hub (Training Catalogue and Platform)

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D9.2 / EOSC Knowledge Hub (Training Catalogue and Platform)

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Abstract

In order to provide a centralised and coordinated response to all training related needs of EOSC, the EOSC Future project began the development of the EOSC Knowledge Hub (KH). Consisting of a Training Catalogue (TC) and a Learning Management System (LMS), the KH will on the one end present the metadata of learning and training resources and, on the other directly host learning and training resources produced by the EOSC Future project as well as by other relevant providers of EOSC related training (mainly self-paced courses and the contents and materials that are included). The aim of the KH is becoming the EOSC point of reference for a variety of stakeholder (actor) groups involved or about to get involved in EOSC.

Version History

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Glossary

EOSC Future project Glossary is incorporated by reference: https://wiki.eoscfuture.eu/x/JQCK

List of Abbreviations

Acronym	Definition
AAI	Authentication and Authorisation Infrastructure
API	Application programming interface
D9.1	Deliverable 9.1
D9.2	Deliverable 9.2
EOSC	European Open Science Cloud
EPOT	EOSC Portal Onboarding Team
ETHRD IG	Education and Training on Handling Research Data Interest Group
FAIR	Findable, Accessible, Interoperable, Reusable
KERs	Key Exploitable Results
KH	Knowledge Hub
LMS	Learning Management System
MVE	Minimum Viable EOSC
RDA	Research Data Alliance
RDM	Research Data Management
SCORM	Sharable Content Object Reference Model
SSHOC	Social Sciences and Humanities Open Cloud
T9.3	Task 9.3
TC	Training Catalogue
TCB	Technical Coordination Board
xAPI	Experience API
WP	Work package

1 Executive Summary

This Deliverable 9.2 (D9.2) focuses on the process of design and development of the EOSC Knowledge Hub (KH), and specifically of its two components, the **Training Catalogue** and the **Learning Platform**.

Designed to ensure and enhance FAIR sharing and reuse of training resources in EOSC as well as to support and foster the development and delivery of EOSC training and skill-building activities, the KH provides an in-house built training catalogue and a Moodle-based LMS that incorporates state-of-the-art specifications, components and solutions.

Providing an EOSC-shaped in-house TC and a Moodle-based LMS, the KH represents a long-term, sustainable solution for EOSC beyond the EOSC Future project.

The KH overall architecture takes into account and builds on the most relevant and consolidated concepts and technologies employed and validated in other projects and initiatives, also including prototypes developed by cluster projects like TeSS (ELIXIR Training Registry) and/or existing initiatives like FOSTER [1]

In particular, the training catalogue specifications, in terms of metadata designation, receive and embed the most up-to-date identifications and definitions detailed by the RDA ETHRD IG (Research Data Alliance - Education and Training On Handling Of Research Data Interest Group) on the minimal metadata application profile, adjusted to respond to the specific EOSC Future project needs and adapted to fit the main EOSC Future portal structure.

Similarly, the LMS, based on the consolidated and open-source Moodle architecture, and integrating a renowned and easy-to-use authoring tool for course development, provides a space that allows for synchronous as well as self-paced learning.

This deliverable illustrates and examines all steps, actions and solutions adopted during the design and development process followed by WP9, Task9.3. This Task, in coordination with other relevant WPs (WP4, WP5, and WP7), identified and developed the specifications of the two components of the KH, and then passed these on to WP5 for implementation and KH technical development. Both specifications and technical developments were subsequently validated by WP7 in order to ensure full operability within the EOSC Portal.

Next steps envisaged for WP9 pertain to the finetuning of the user experience within the KH, including monitoring the use, ensuring content creation and curation, and advising WP5 and WP7 on improvements and/or changes in the KH functionality and delivery mode.

The document details all the activities that were undertaken to gather information and best practices, examine existing solutions and tools, analyse current gaps and challenges, consolidate and integrate the outcomes of previous projects and initiatives, and prioritise and harmonise requirements and specifications in order to develop the most effective, efficient and responsive Knowledge Hub for EOSC training needs.

Moreover, D9.2 builds upon and validates and, where appropriate, tests, revises and improves the Training Catalogue and Learning Platform specifications as defined in the D9.1.

Section 2 Introduction provides the context for the activities described in later sections.

Section 3 Training Catalogue outlines the activities and solutions implemented with regards to the specifications of the catalogue, with particular reference to the identification of the metadata set, the design of the main catalogue functionalities selected in light of the user needs and actions, and the operation of the harvesting process, divided by existing and new resources. In doing so, Section 3 also provides an account of the collaborative work conducted by WP9/T9.3 together with other EOSC Future Work Packages and Tasks. It illustrates the consultations initiated by T9.3 involving other projects and initiatives that developed and host their own training catalogues, and that are likely to become resource providers for the EOSC KH.

Section 4 Learning Platform describes the requirements, considerations and solutions adopted for the Learning Platform vis-à-vis EOSC specific course/training development and hosting needs, and also in relation to the envisaged interoperability with the training catalogue. In particular, Section 4 examines the steps followed to implement the two components of the learning platform, the learning management system and the authoring tool. A brief account is also given with reference to the solution adopted for training resources storage

and database. The Section then closes with a brief outline of the main actions that are expected to take place after the first release of the KH.

Section 5 KERs covers how the EOSC KH fits into a wider strategy for EOSC and its sustainability in the long-term, as it has been identified as a key exploitable result (KER) of the EOSC Future project.

Section 6 presents the main conclusions for each individual theme, including, where applicable, suggestions for future work. It also provides a brief account of the main challenges and most important lessons learnt during the design and development process, illustrating the solutions implemented to overcome obstacles and problems.

2 Introduction

As advancements made in the technical activities of the EOSC Future project are leading towards a more fully fledged EOSC, the need for developing and delivering a centralised training catalogue aimed at EOSC end-users and providers to offer know-how on its usage also emerged.

In fact, while it was recognised that many training resources had already been created through activities of previous and on-going projects that fed into building EOSC, it became increasingly clear that these resources needed to be actively aggregated into a single point of entry that would serve the needs of the wider EOSC community.

To this end, WP9 T9.3 was constituted and mandated to work towards the achievement of "Specific Objective 6.4: Build and operate a learning management system and training catalogue as integral parts of the EOSC Portal to sustain the EOSC Knowledge Hub". The aim of the KH is to provide a centralised location for training related to EOSC and become the de facto point of reference for all users of EOSC wishing to find training, regardless of the stakeholder (actor) group.

The implementation of this technical platform, the EOSC KH, composed of two complementary and interoperable services, the Training Catalogue and the Learning Platform (interrelated as shown in Figure 2.1), constitutes the result of the activities that T9.3 conducted, along with WP5, in the initial 18 months of the present project.

The KH development, on which this Deliverable focuses builds on what is detailed in D9.1 - EOSC Training Catalogue and Learning Platform specification (KH) delivered at M6 in order to provide the foundational framework from which further discussion and implementation could proceed. Technical implementation was led by WP5 T5.3, requiring constant and close dialogue between WP9/WP5.

While the initial specifications, functionalities and main user actions of the KH were detailed previously in D9.1, this report provides an account of their practical implementation, achieved through a continuous dialogue with WP5 and other relevant WPs; in consultation with a select number of pilot catalogues, that contributed to the analysis of the existing tools and conditions; and in accordance with the RDA Interest Group on Education and Training on Handling of Research Data Interest Group (ETHRD IG), that supported the definition of a minimal metadata set for the onboarding of training resources. Similarly, for the learning management system (LMS), the activities started from an analysis of existing tools and solutions, through a scoping exercise aimed at assessing the most efficient and effective platforms, and which allowed us to identify a learning platform best suited for EOSC's needs, as well as an authoring tool that fits the skills and expertise most relevant among the prospective EOSC trainers and providers.

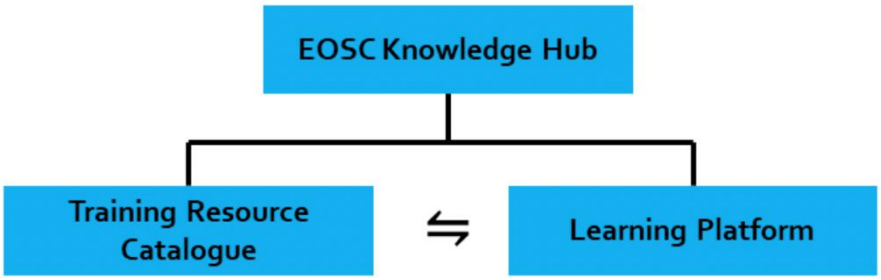

Figure 2.1: EOSC Knowledge Hub Architecture

3 Training Catalogue

Since its inception, EOSC Future has focused on consolidating and connecting key stakeholders, actors and initiatives in EOSC in order to strengthen and extend the EOSC ecosystem. This process has also pertained to the way in which EOSC is approached, perceived and used by the wider research community and therefore required the implementation of a number of training actions and initiatives aimed at extending the EOSC ecosystem while also improving its commitment to EOSC.

One of these training initiatives that was identified is the creation of a Training Catalogue, that constitutes an important piece in the Minimum Viable EOSC[2] as it is believed it would help train the research community, and thus enable open science and FAIR data.

One of two components of the EOSC KH, the EOSC Training Catalogue is a catalogue of training resources pertinent to EOSC, and which consists of

- a database,
- an advanced search interface and
- landing pages for training resources that have been aggregated or directly onboarded.

The catalogue is open to all relevant training resources that fulfil the onboarding procedures and rules of participation for training service providers, supporting metadata harvesting of external portals and registration of training materials. To ensure consistency, the Training Catalogue works in a similar way to the EOSC Marketplace, whilst only containing training resources.

This section provides an account of the main issues that were faced and related activities that were implemented towards the delivery of the EOSC Training Catalogue.

3.1 Metadata Set

One of the most relevant and characteristic elements for any training catalogue are the metadata fields which on one end are requested from providers to onboard resources, and on the other end provide end-users with the search capabilities, and in particular of those specific training resources that can address her/his training needs. The metadata set to be defined and used for the EOSC Training Catalogue has therefore been a priority issue to discuss.

The discussions about the metadata set to be used for our training catalogue, that build on the specifications included in D9.1 and incorporate the recommendations received from WP5, started from the definition of the overall approach that the project intended for the EOSC Training Catalogue.

Three elements were taken into consideration: 1) the objective of establishing the EOSC Training Catalogue as a reference point and aggregator of existing catalogues; 2) the intent to combine and develop resources in a way that could generate an added value in the form of learning paths; and 3) a focus on providing end-users with as much relevant information as possible but at the same time favouring training resource onboarding to make the process as smooth as possible for training resource providers.

The combination of these three elements immediately made evident: 1) the need for compromise among varying opinions on what should be included in the list of fields in the metadata set, and second for what should be considered mandatory/not mandatory for each of these fields; 2) the need to ensure the highest quality standards possible for the resources included in the EOSC Training Catalogue and the possibility to generate value services; and, 3) the minimal information to provide to end-users for proper selection of learning resources.

The need for a balance therefore called for a level of flexibility in the chosen metadata set, especially concerning the mandatory fields for onboarding.

3.1.1 Metadata Identification

The reflections on the metadata set started from the solid foundation of the work done by the RDA ETHRD IG [3] . The RDA minimal metadata set [4] - considered the most relevant set currently available - was therefore taken as an initial reference and an EOSC-customised version of that set was created.

In close alignment with the RDA ETHRD IG, and in light of their specific work to produce an RDA output for a minimal metadata set for training resources, T9.3 (and T5.3) created a metadata set specification that responded to the requirements of the EOSC Training Catalogue.

This metadata set includes 14 fields which were then discussed in-depth and adapted for EOSC purposes and that are detailed in full in Table 3.1.

Table 3.1: RDA Minimal Metadata for Learning Resources customised for the EOSC training resources

Name	Definition	Type [1]	Usage notes, allowed values, examples, other constraints
Title	The human readable name of the learning resou rce.	TEXT (1000)	**Notes**: It should be transcribed from the learning resource itself or the descriptive metadata found on the resource landing page. If no title exists, the provider should create it. If the resource exists in more than one language, a separate record should be created for that version. **Allowed values**: Should be Unicode and allow for diacritics. **Example**: "CESSDA Data Management Expert Guide" **Constraints**: Not repeatable
Abstract/ Description	A brief synopsis about or description of the learning resource.	TEXT (2000)	**Notes:** The description can include the relationship of this resource to others, if applicable, e.g., a part within a series or collection, and the existence of translations of the resource into other languages. **Allowed values**: Should be Unicode and allow for diacritics **Example**: "A guide designed by European experts to help social science researchers make their research data Findable, Accessible, Interoperable and Reusable (FAIR)." **Constraints**: Not repeatable
Author(s)	The name of entity(ies) authoring the resource.	TEXT	**Notes:** Authors should be listed in the order presented on the resource or on the descriptive metadata on the landing page of the resource. Multiple authors should be listed with commas between the names. Names should include given or first name and family or surname, and a personal identifier such as an ORCID, if available. Some input systems may offer separate fields for each of these identifying items. **Allowed values**: Should be Unicode and allow for diacritics **Example**: "CESSDA Training Team" **Constraints**: Repeatable
Primary Language	The language in which the resource was originally published or made available.	TEXT (2)	**Notes:** If the resource exists in more than one language, that information can be included in the Abstract/Description term. A second record should be created, if possible, for the other language versions of the resource. **Allowed values**: String composed by a code as defined by the code set ISO 639-1:2002 **Example**: "en" **Constraints**: Not repeatable
Keyword(s)	The keyword(s) or tag(s) used	TEXT (100)	**Notes**: Keywords may be single words or phrases that characterise what the resource is about. Ideally, the keywords come from a controlled vocabulary of terms that are curated and structured to represent the

[1] https://www.w3schools.com/sql/sql_datatypes.asp

	to describe the resource.		specific nature of the collection of learning resources, e.g., by subject domain, data format and/or data type. In a web or searchable catalogue / web environment for learning resources, keywords are important to the search engine optimization (SEO) strategy of the environment, and are used in conjunction with resource titles, descriptions and other educational information such as target audience to improve the findability of the resource on the web or within the catalogue / registry. Keywords are sometimes called "tags" in non-academic environments. **Allowed values**: Free text or keywords from a given vocabulary **Example**: data management, data preservation, data discover **Constraints**: Repeatable
Licence	A licence document that applies to this content, typically indicated by URL.	TEXT (100)	**Notes:** The licence is used to represent and classify data access policies related to the training resource. It can be a short label indicating the licence (e.g., CC BY 4.0) or a full label (e.g., Creative Commons Attribution 4.0 International) or the complete definition (e.g., The data are available under the Creative Commons Attribution 4.0 International Public Licence [5]. **Allowed values**: Free text or keywords from a given vocabulary, e.g., the NERC Vocabulary Server (NVS) [6] **Example**: "Creative Commons Attribution 4.0 International" **Constraints**: Not repeatable
Version Date	The version date for the most recently published or broadcast resource.	DATE	**Notes**: This date may relate to either the publication of a new version of a resource or the modification date of an original version. If the original version of a resource is changed significantly, it may be better to create a new description of the newer version rather than change the version date, especially if the older version of the resource will continue to be made available (similar to a new "edition" of a published entity). **Allowed values**: Date Format: YYYY-MM-DD IETF RFC3339 | ISO 8601; To indicate a date range, follow the RKMS-ISO8601 standard for depicting date ranges. **Example**: "2020-11-12" **Constraints**: Not repeatable
URL to Resource	The URL that resolves to the learning resource or to a "landing page" for the resource that contains important contextual information including the direct resolvable link to the resource, if applicable.	TEXT (1000)	**Notes**: As this value is intended to at least specify where a resource exists and the mechanism for retrieving it at a resolvable location, it should follow the syntax of URL: http://www.domainname.com/folder-name/web page-file-name.htm. The URL could also point to a "landing page" for the resource that could include other contextual information, especially if the resource is related to others such as a member of a set or collection of resources. Ideally, the URL would also be a persistent identifier (PID) that provides a long-lasting reference to the resource such as those created and supported by PID systems such as Digital Object Identifiers (DOIs) or Archival Resource Keys (ARKs). **Allowed values**: URL syntax **Example**: "https://www.cessda.eu/Training/Training-Resources" **Constraints**: Not repeatable
Resource URL Type	The designation of the identifier scheme used for the resource URL.	TEXT (40)	**Notes**: It represents the type of the URL of the resource, that is the used scheme (e.g., Web Address URL, DOI, ARK, etc.). **Allowed values**: Ideally the values used will come from a controlled vocabulary, e.g., the related IdentifierType from DataCite [7] **Example**: "DOI" **Constraints**: Not repeatable

Target Group (Audience)	The principal users(s) for which the learning resou rce was designed.	TEXT (40)	**Notes**: It indicates the target group(s) for which the training resource has been designed and implemented. **Allowed values**: free text (or codes from an existing vocabulary) **Example**: "Data centre staff" **Constraints**: Repeatable
Learning Resource Type	The predominant type or kind that characterises the learning resource.	TEXT (40)	**Notes:** Different metadata schemes employ this element to indicate other factors regarding the learning resource type. For instance, LOM indicates the potential educational use(s) or type(s) of content associated with the LR, see example below. LRMI uses a concept scheme Other values are indeed relevant only to its format or genre (diagram, figure, graph, index, slide, table, narrative text). The vocabulary terms are defined as in the OED: 1989 and as used by educational communities of practice. **Allowed values**: Ideally, this list of types should come from a controlled vocabulary that is actively maintained and curated. **Example**: "Narrative text" **Constraints**: Not repeatable
Learning Outcome(s)	The descriptions of what knowledge, skills or abilities students should acquire on completion of the resource.	TEXT (1000)	**Notes**: It indicates the learning outcomes after the completion of the training resource. **Allowed values**: free text **Example**: "At the end of this course the participants will be able to make their research data Findable, Accessible, Interoperable and Reusable (FAIR)." **Constraints**: Repeatable
Access Cost	The potential cost associated with the learning resource.	TEXT (8)	**Notes**: It indicates if the learning resource has an access cost. **Allowed values**: yes, no, maybe with recommendation that further explanation of "Maybe" goes in the Description field for "It depends" or "It changes" explanations). **Example**: "no" **Constraints**: Not repeatable
Expertise Level	Target skill level in the topic being taught.	TEXT (40)	**Notes:** It indicates the expertise level required for the specific learning resource. **Allowed values**: free text (or codes from an existing vocabulary e.g., beginner, intermediate, advanced, etc.) **Example**: "beginner" **Constraints**: Not repeatable

3.1.2 Adapted RDA Minimal Metadata Set and Usage

It soon became evident however, how the specifications included in this EOSC-customised set could potentially generate a number of challenges as it did not fully address the concerns highlighted above. In particular, it emerged that this metadata set, considering that most of the existing training resources that can be found online often do not include information about all the fields listed in the RDA metadata set, could result quite restrictive thus posing challenges with regards to the harvesting and onboarding of training resources into the Training Catalogue. Ultimately, this would sensibly reduce the amount of training resources that can be hosted on the EOSC Training Catalogue.

As a consequence, Task 9.3 resolved to hold a series of meetings with a number of identified Pilot Catalogues (ELIXIR TeSS, SSH Training Discovery Toolkit, DARIAH Campus, EOSC-Pillar) in order to present the proposed

initial metadata set, examine the solutions adopted by various other projects, assess the applicability of the envisaged metadata set, and validate the KH solution. These were also complemented by other discussions that WP9 had with the FAIRsFAIR consortium [8] .

The reflections and evaluations generated after these meetings led to a revision of the RDA Minimal Metadata Set with particular reference to the mandatory/not mandatory character of the 14 fields that compose the set. Specifically, the 14 fields of the RDA metadata set were all confirmed but it was decided that, in order to facilitate harvesting/onboarding of resources, only a certain number of them was to be defined as mandatory, while the remaining ones would be marked as recommended or optional. And the rationale behind each of the three different levels was defined as follows:

- **mandatory fields**: information required for harvesting/onboarding of resources. Lack of these fields would mean that the resource cannot be harvested/onboarded;
- **recommended fields**: information extremely relevant for use/reuse of resources. Lack of these fields would mean that the resource is unlikely to be used further (e.g. combination with other resources, inclusion in a learning path, etc.)
- **optional fields**: information that are neither mandatory nor recommended but that, if provided, contribute to the completeness of the details provided about a resource.

Keeping in mind all the considerations above, it was agreed to define two different metadata sets that would respond to two different scenarios: the first one aimed at the aggregation of existing resources (Table 3.2, see below) and the second one to be applied at the registration of new resources (Table 3.3, see below).

3.1.2.1 Existing resources

The metadata set aimed at existing resources (Table 3.2) includes a very limited number of mandatory fields, the bare minimum requested to identify a resource, in favour of a majority of recommended fields. This allows the Training Catalogue to be as inclusive as possible and harvest/onboard a vast number of resources. In this case however, the training resources providers will be also informed, via some predefined and automated alert messages, that not providing any information for the recommended fields will result in a limited re-usability of their resources.

Table 3.2: Metadata Set for Existing Resources (for the first harvesting process)

Metadata Field	Mandatory	Recommended (info that if not provided will limit the use of the resource)	Optional
Title	Y		
Description		Y	
Author (s)	Y		
Language (different resources for different languages)		Y	
Keywords		Y	
Licence		Y	
Access Rights (open, closed, restricted, with a cost, etc.)		Y	
Version Date(s)		Y (with high importance)	
URL to resource	Y		
Resource URL type			Y
Target Group (Audience)		Y	
Learning Resource Type			Y
Learning Outcome		Y	
Expertise Level		Y	

The expectation is that this will encourage EOSC training providers to curate the metadata of their resources in order to ensure their full use. To this extent, in the initial phase two issues will be carefully addressed: properly communicating the meaning of "recommended" metadata fields and the consequences of missing information; and internal curation of resources in order to ensure potential reuse once onboarded.

3.1.2.2 New resources

The metadata set to be applied at the registration of new resources (Table 3.3) follows the same approach of mandatory, recommended and optional fields (with alert messages), but includes a much wider list of mandatory fields that matches almost entirely the list of mandatory fields that were defined by the RDA group.

The differences in the list of the mandatory fields identified in these two approaches reflect all the considerations and discussions held in the design phase and appeared to be the best solution in order to address the three crucial elements identified as part of the overall EOSC Training Catalogue approach (see section 3.1 above). In both cases the aim is always to make training resources as FAIR compliant as possible.

Table 3.3: New materials (for registrations directly in the catalogue)

Metadata Field	Mandatory	Recommended (info that if not provided will limit the use of the resource)	Optional
Title	Y		
Description		Y	
Author (s)	Y		
Language (different resources for different languages)	Y		
Keywords		Y (with high importance)	
Licence		Y	
Access Rights (open, closed, restricted, with a cost, etc.)	Y		
Version Date(s)	Y		
URL to resource	Y		
Resource URL type			Y
Target Group (Audience)	Y (controlled vocabulary)		
Learning Resource Type		Y	
Learning Outcome	Y (controlled vocabulary)		
Expertise Level	Y (controlled vocabulary)		

It is hoped that, with time, more and more training resource providers will embrace the approach for a complete list of mandatory fields, therefore contributing to progressively providing fully detailed training resources.

3.1.3 EOSC Provider Profile Data Model

The metadata specifications presented above were the basis for designing the EOSC Provider Profile for training resources. This element was taken into consideration during the activities aimed at the definition of the Training Catalogue metadata set and thereby integrated, refers to the EOSC Provider Profile (EPP), one of the EOSC Portal Profiles part of the EOSC Interoperability Framework.

The EOSC Profiles in general refer to the various EOSC entities and to the different phases of the onboarding, update, maintenance, and monitoring processes in order to define common data models for each of them. The EOSC Provider Data Model in particular, defining attributes, format/type (if any), multiplicity, and mandatory/optional character for the implementation of a number of features in Catalogue, contributes to the unified framework for describing and offering EOSC Resources to end-users in a harmonised way, guaranteeing the interoperability of resources metadata with open APIs.

In order to consolidate into the Training Catalogue the information defined at the EOSC Portal level, ensuring system consistency, the EOSC Provider Data Model (Table 3.4) also informed the fields of the Metadata Set.

Table 3.4: Established Data Model for Training Providers

Basic Information					
Attribute Name	**Definition**	**Type**	**Multiplicity**	**Required**	**Public**
Title	The human readable name of the learning resource.	String (100)	1	Mandatory	Yes
Resource Organisation	The name of the organisation that manages or delivers the resource, or that coordinates the Resource delivery in a federated scenario.	ProviderID	1	Mandatory	Yes
Resource Providers	The name(s) of (all) the Provider(s) that manage or	ProviderID	Multiple	Optional	Yes

	deliver the Resource in federated scenarios.				
Authors	The name of entity(ies) authoring the resource.	String (40)	Multiple	Mandatory	Yes
URL to resource	The URL that resolves to the learning resource or to a "landing page" for the resource that contains important contextual information including the direct resolvable link to the resource, if applicable.	URL	1	Mandatory	Yes
Resource URL type	The designation of the identifier scheme used for the resource URL. It represents the type of the URL of the resource, that is the used scheme (e.g., Web Address URL, DOI, ARK, etc.).	Controlled Vocabulary.	1	Optional	Yes
Detailed & access Information					
Attribute Name	**Definition**	**Type**	**Multiplicity**	**Required**	**Public**
Description	A brief synopsis about or description of the learning resource.	String (1000)	1	Recommended	Yes
Keywords	The keyword(s) or tag(s) used to describe the resource.	String (100)	Multiple	Recommended	Yes
Licence	A licence document that applies to this content, typically indicated by URL.	String (100)	1	Recommended	Yes
Access Rights	The access status of a resource (open, restricted, paid).	Controlled Vocabulary	1	Mandatory	Yes
Version Date(s)	The version date for the most recently published or broadcast resource.	Date	1	Mandatory	Yes
Learning Information					
Attribute Name	**Definition**	**Type**	**Multiplicity**	**Required**	**Public**
Target Group (Audience)	The principal users(s) for which the learning resource was designed	Enumerated (Resource Target Users)[2]	Multiple	Mandatory	Yes
Learning Resource Type	The predominant type or kind that characterises the learning resource.	Controlled Vocabulary	Multiple	Recommended	Yes
Learning Outcome(s)	The descriptions of what knowledge, skills or abilities students should acquire on completion of the resource.	String (1000)	Multiple	Mandatory	Yes
Expertise Level	Target skill level in the topic being taught.	Controlled Vocabulary	1	Mandatory	Yes
Content resource type	The predominant content type of the learning resource (video, game, diagram, slides, etc.).	Controlled Vocabulary	Multiple	Recommended	Yes
Qualification	Identification of certification, accreditation or badge obtained with a course or learning resource.	Controlled Vocabulary	1	Recommended	Yes
Duration	Approximate or typical time it takes to work with or through the learning resource for the typical intended target audience.	String (40)	1	Recommended	Yes
Geographic and Language Availability Information					
Attribute Name	**Definition**	**Type**	**Multiplicity**	**Required**	**Public**

[2] https://wiki.eoscfuture.eu/display/PUBLIC/B.+v4.00+EOSC+Resource+Profile#B.v4.00EOSCResourceProfile-ResourceTargetUsers

Language	The language in which the resource was originally published or made available.	Enumerated (Resource Language Availability)[3]	Multiple	Mandatory	Yes
Geographic Availability	Locations where the Resource is offered.	Enumerated (Resource Geographical Availability)[4]	Multiple	Mandatory	Yes
Classification Information					
Attribute Name	**Definition**	**Type**	**Multiplicity**	**Required**	**Public**
Scientific Domain	The branch of science, scientific discipline that is related to the Resource.	Enumerated (Resource Scientific Domain)[5]	Multiple	Mandatory	Yes
Scientific Subdomain	The sub branch of science, scientific subdiscipline that is related to the Resource.	Enumerated (Resource Scientific Domain)[6]	Multiple	Mandatory	Yes
Contact Information					
Attribute Name	**Definition**	**Type**	**Multiplicity**	**Required**	**Public**
First Name	First Name of the Resource's main contact person/Resource manager.	String (max 20)	1	Mandatory	No
Last Name	Last Name of the Resource's main contact person/Resource manager.	String (max 20)	1	Mandatory	No
Email	Email of the Resource's main contact person/Resource manager.	Email	1	Mandatory	No
Phone	Telephone of the Resource's main contact person/Resource manager.	String (max 20)	1	Optional	No
Position	Position of the Resource's main contact person/Resource manager.	String (max 20)	1	Optional	No
Organisation	The organisation to which the Resource's main contact person/Resource manager is affiliated.	String (max 50)	1	Optional	No

3.2 Coordination and Collaboration with other WPs and Tasks

Overall coordination of activities in Task 9.3 was undertaken through monthly meetings that, in most cases, provided a sufficient space for discussions and decision-making processes. Some specific activities however, required the organisation of additional scheduled and *ad hoc* meetings that could provide a forum in which work relevant in other tasks and WPs could be highlighted and actioned where applicable.

In particular, Task 9.3 deemed necessary to hold meetings with Task 5.3 aimed at coordinating the efforts towards the development of the KH as per specifications detailed in D9.1 and further refined in subsequent discussions, and with Task 5.1 in order to discuss and integrate findings and suggestions received by a Training Catalogue focus group elsewhere established (see 3.2.2).

[3] https://wiki.eoscfuture.eu/display/PUBLIC/B.+v4.00+EOSC+Resource+Profile#B.v4.00EOSCResourceProfile-ResourceLanguageAvailability
[4] https://wiki.eoscfuture.eu/display/PUBLIC/B.+v4.00+EOSC+Resource+Profile#B.v4.00EOSCResourceProfile-ResourceGeographicalAvailability
[5] https://wiki.eoscfuture.eu/display/PUBLIC/B.+v4.00+EOSC+Resource+Profile#B.v4.00EOSCResourceProfile-ResourceScientificDomain
[6] https://wiki.eoscfuture.eu/display/PUBLIC/B.+v4.00+EOSC+Resource+Profile#B.v4.00EOSCResourceProfile-ResourceScientificDomain

3.2.1 Task 5.3 - Implementation of Technical Specifications

Through scheduled and *ad hoc* meetings, T9.3 and T5.3 at first stage discussed the provisions contained in D9.1 in order to better define, refine and align expectations and feasibility of the solutions envisaged for the KH. After the completion of this process, these periodic meetings became instrumental for constant coordination of the technical development of the KH.

The discussions conducted initially with reference to the above were exhaustive in their approach and sometimes raised as many questions as it solved, but ultimately allowed closer alignment and produced a joint vision for the KH. After initially finding common ground on the overall KH approach, discussions then moved onto a series of practical considerations including:

- Definition and management of a metadata set for learning resources, courses and/or curricula for search and browsing;
- Search/browse functionalities for training resources (e.g. keyword search, advanced search using boolean operators and browse the catalogue both via a web interface (human readability) and an API (machine readability);
- Display of landing pages of external training catalogues;
- Registration and login to access metadata records;
- Manual training resources metadata record creation (for manual onboarding);
- Review process (for training metadata);
- PID schema;
- User feedback workflow;
- User profile management;
- Help desk;
- Aggregation mechanism;
- Versioning of metadata;
- Security implementation.

All the issues discussed during this process and the related adopted solutions are reported in a project Wiki page that can be found at the link https://wiki.eoscfuture.eu/pages/viewpage.action?pageId=16876443.

3.2.2 Task 5.1 - Focus Group

A Training Catalogue focus group, whose members' characteristics (disciplines and geographic distribution) are shown in **Figure 3.1** was assembled by WP10 to learn about best practices from the users on other platforms or simply from their learning experiences.

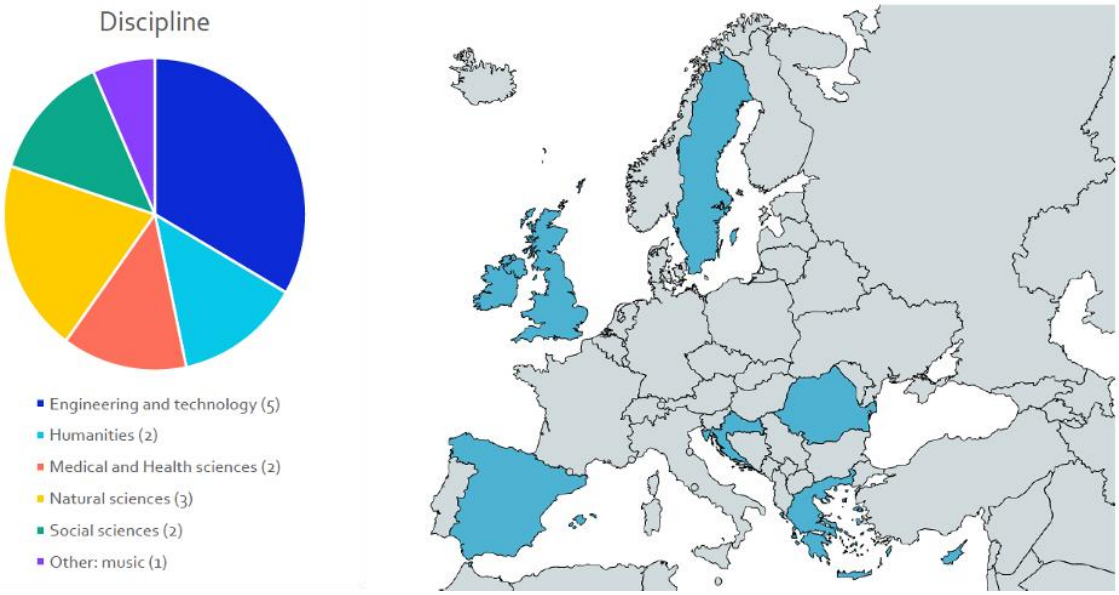

Figure 3.1:Discipline and geographic distribution of focus group

A beta version of the Training Catalogue was presented to this focus group to further optimise it and gather user requirements for the next versions of the training catalogue. The focus group provided valuable inputs both regarding the Training Catalogue with valuable comments and suggestions regarding the overall structure and architecture and the metadata set, as well as on the learning platform with particular reference to training disciplines and contents.

The focus group provided references and examples on the most successful and efficient search modalities and interfaces, on the most appreciated functions of existing training platforms, on user experience and search filters. Moreover, they provided first hand perspectives on the most common users' training needs, on the most relevant and effective training resource types and requirements, on the importance of peer discussions, and on the main users' motivations behind choosing from a relatively long list of results one course instead of another. On this last point in particular, an interactive exercise, whose results are shown in Figure 3.2, was conducted using Google Jamboard.

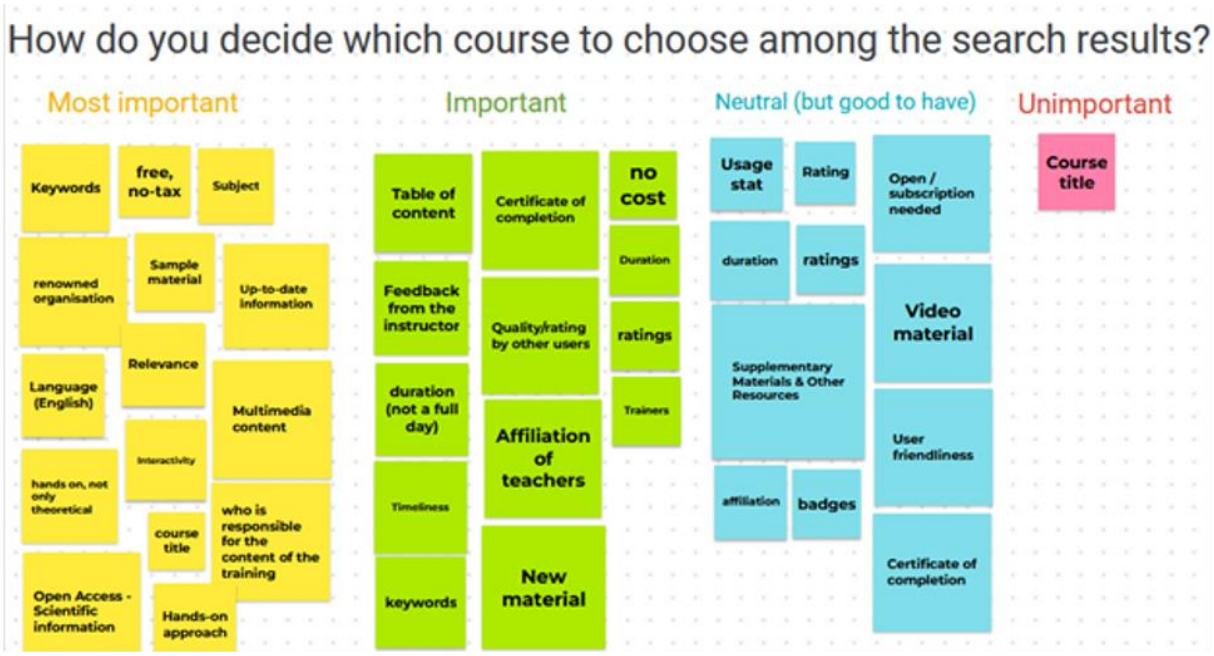

Figure 3.2: Results from focus group discussion

In particular, the focus group inputs allowed identification of a number of relevant elements that influence course selection, such as the coherence of a course's title and actual contents; the presence of up-to-date information about the course and relevant keywords; the duration/length of the course; the availability of interactive materials and sample materials to judge the quality and content of the training resource; the evaluation of the training outcome; the possibility of feedback from an instructor; and a community supporting the learning process.

Similarly, the planned metadata set was also presented to the focus group and was judged as complete and exhaustive. Some suggestions for improvement were provided with reference to the "mandatory"/"not mandatory" aspects of certain metadata and with specific reference to the format of the learning resources that should be dealt with in the "Resource type" field.

The focus group also proposed a few additional elements related to the KH that could be seen as valuable and appreciated by the end-users, and especially researchers. Stemming from the fact that looking for training resources is not a typical task for researchers, finding training resources for a new research tool in a researcher's project may prove to be difficult, and the focus group suggested that having a "recommender system" that could propose related courses when searching for specific kinds of resources would be an extremely helpful feature for end-users. Similarly, offering a "simple search" platform with access to advanced filtering options was identified as very valuable as was the possibility to sign up to receive notifications about course updates.

All these reflections and suggestions informed the development of the KH in its two components.

In conclusion, the focus group deemed the proposed metadata fields as complete, while also warning against establishing a number of metadata fields that could create an extra burden to providers at the time of uploading training resources.

3.3 Consultations with Pilot Catalogues

3.3.1 DARIAH, ELIXIR-TeSS, EOSC-Pillar, SSHOC

Four pre-existing catalogues from the SSHOC, ELIXIR (TeSS), EOSC Pillar and DARIAH projects were selected as pilot catalogues to be used as a testbed for the EOSC KH.

Bilateral meetings were scheduled with each of them in order to individually discuss their experiences and workflows to establish their metadata requirements. The purpose of these meetings was twofold, on the one end they aimed at presenting the KH's vision and proposed solutions while, on the other, gauge the feasibility of aligning the pilots with what T9.3 proposed through its RDA ETHRD minimal metadata set. The purpose of the ETHRD metadata is to establish a new standard for learning resources which will provide interoperability and sustainability and which WP9 has recognised as a key enabler for the KH's objectives.

A number of relevant issues were discussed during these meetings, which always started with the presentation of the EOSC Knowledge Hub, a general introduction of its main aspects and specifications, and an overview of how the piloting process would proceed. The KH Inclusion criteria, policies and content, onboarding process and guide, as well as the workflow for onboarding a training resource from the providers perspective were the first issues to be discussed. Other issues referred to other onboarding details, such as metadata issues and registrations procedures, the compliance with the mandatory and optional metadata fields, and proposals about the registration procedures (APIs, interfaces, endpoints). These meetings were also instrumental to refine a number of issues still open in the Training Catalogue specifications, such as those related to controlled vocabularies, the definition of learning content types, resources access cost/rights, etc.

In addition to these bilateral meetings, Task 9.3 also arranged a joint meeting with all the pilots present to facilitate crosstalk amongst the pilots and to better define the EOSC Training Catalogue own requirements. In all 4 cases, the discussions held concluded that alignment and inclusion of these disparate catalogues with the EOSC Training Catalogue would, with the necessary adjustments, be feasible. And therefore, the need to define a curation strategy was also identified.

Moreover, moving on from these pilots, T9.3 identified additional targets where possible and also aligned new resources created through T9.2 with the RDA minimal metadata specification to be included in the KH.

3.4 Functionality

The Training Catalogue has a standard set of functionalities: 1) search and 2) access training resources for learners and 3) onboarding for training providers.

3.4.1 Search

One of the key features of the Training Catalogue is the search and filter tool. Given the vast spectrum of disciplines in science, a successful Training Catalogue will contain an increasingly large number of training resources. Users will thus need an easy and convenient way to sort and filter through the resources available in the Training Catalogue (a catalogue with the resource a user wants but cannot find is of no use after all).

To facilitate finding the right training content, a search bar will be available.

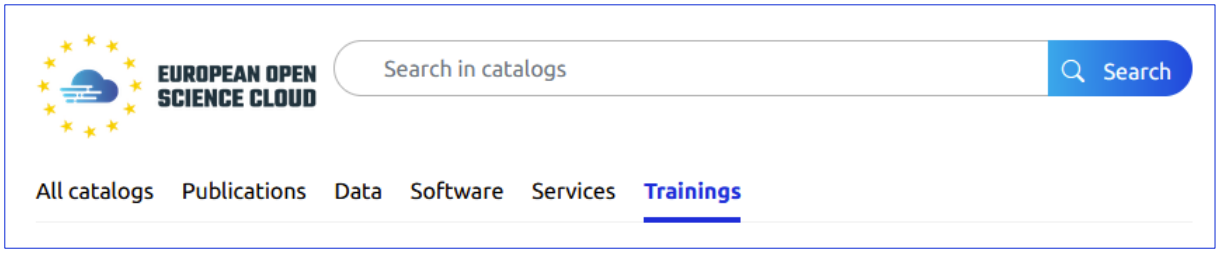

Figure 3.3: Training Catalogue search bar

To complement the search bar different filters have been added based on the metadata available via the onboarding, such as:

- Resource type (is it a guide, a webinar, slides, etc?);
- Content type (is it PDF, video, etc?);
- Language;
- Organisation (provider of the training);
- Level of expertise;
- Target group;
- Duration;
- Date of creation.

It is expected that the filters provided will evolve with the Training Catalogue, as focus groups first, and real end-users later, provide feedback to developers. In any case there will always be a trade-off between the search and filter for users and the facility to onboard for providers: the more up to date and broad metadata that are available, the better for the users.

3.4.2 Access and Usage

Individual training resources, where applicable, will be used via the resource provider's own training platform and not in the Training Catalogue itself, which means that users will be redirected outside the Training Catalogue once they identify a specific training of relevance. This is done on purpose to ensure that the KH's Training Catalogue can host any kind of training, and that we do not duplicate resources that can be found on an original training resource providers' site. Similar to other catalogues, we are merely storing the metadata for those resources. Furthermore, this also ensures that we do not restrict the tools that training providers can use while ensuring that the cost of running it remains acceptable (so we have a sustainable output).

3.4.3 Onboarding and Rules of Participation (RoP)

Onboarding instructions, in coordination with work in Task 9.1 and the EOSC Portal Onboarding Team (EPOT), have been discussed.

3.4.3.1 Onboarding procedures for EOSC Providers who want to include training resources in the Knowledge Hub [9]

- A Provider starts registration in the EOSC Portal, using current EPOT onboarding workflows [10] . The training providers need to be onboarded onto the Marketplace as any other resource providers. Once a Provider is approved by EPOT the provider can on-board services and training resources.
- If a Provider wants to include its training resources in the EOSC Training Catalogue, i.e. service registration, the EPOT redirects a Provider to the KH, and a service validation process is frozen until the KH registers the resources.
- The KH team is included in the EPOT and is a part of the roster for training resources. The only work of the KH team within the EPOT roster is the validation of the first training resource, and the future validation/auditing of onboarded training resources. EPOT is doing regular audits of RoP and resources and the KH team is involved in the training related ones.
- A Provider fills out a form in the KH Training Catalogue / Marketplace.

- For a manual registration "resource by resource", the KH trusts the resource (no validation, and approval is by default when a form is filled out and validation is done at the Provider level) and gives permission to register training resources. Periodic auditing takes place and the forms ensure that mandatory metadata are supplied before an entry can go into the Training Catalogue.
- Only the first training resource from an onboarded provider will be validated by EPOT; subsequent ones do not need explicit validation.
- There is a synchronisation between the KH Training Catalogue and the EOSC Catalogue/Portal/Marketplace (as there is an additional research product catalogue).
- A master product is always in the Marketplace.
- KH team curates training resources using the curation quality checklist and follows up with a Provider if needed. Some automated curation will be implemented to minimise the workload of the KH team. Audits will be automated as much as possible, with certain checks on URLs for example.
- The Provider agrees to periodically update training resources (and corresponding metadata) to keep them current. If a resource will not be well maintained but may still be useful, a Provider includes a note that maintenance is not continued.

3.4.3.2 Rules of Participation

When discussing onboarding EOSC training resources WP9 could only focus on the content level - e.g. do we need more metadata on training, and which is already addressed in *D9.1 EOSC Training Catalogue and Learning Platform Specification*.

Rules of Participation exist on the EOSC level and not on the EOSC Future project level, which means that we could only discuss the practical implication of the rules for training resources and make recommendations for the newly launched EOSC Association Task Force.

The current version of the Rules of Participation in EOSC [11] (Service Requirements) includes:

> Services and resources of the EOSC Portal are provided and maintained by different providers under a variety of licences. To become a provider we require that:
> - The service is accessible to users outside its original community.
> - The service is described through a common template focused on value proposition and functional capabilities.
> - At least one service instance is running in a production environment available to the user community.
> - Publish Research data which is Findable, Accessible, Interoperable and Reusable.
> - Release notes and sufficient documentation are available.
> - Helpdesk channels are available for support, bug reporting and requirements gathering.

Inclusion criteria for onboarding EOSC Service Providers are within the scope of the EOSC Future project, but WP9 did not want to introduce specific criteria for different types of EOSC Providers and did not expect new entities such as training providers. For example, EGI, GEANT and OpenAIRE already have training onboarded as services in the Marketplace. It was also noticed that not all training is provided by (training) service providers and training is not always connected to specific services, and therefore we made a conscious decision to separate training as a service from training resources. In this sense, some suggestions of how training resources can be presented by providers are:

- Some requirements, such as publishing research data which are FAIR, clearly refer to data and we would like to ensure that training resources are also covered. For example, by saying publish research data and training resources which are FAIR.
- The generic rule - Release notes and sufficient documentation are available - could be rephrased to be more training specific, for example: Training resources are documented for reuse i.e. not just slides, and are up-to-date.

While promoting openness, Rules of Participation could also cover commercial training offerings. In this case however, the project must establish some rules that allow for rejecting training programmes and courses that are not aligned, in terms of access costs, to the overall open science approach.

3.5 Release Plan

The first BETA release of the Training Catalogue was realised in month 16. For this first phase the available functionalities included were:

- Search/browse training resources;
- Display of landing pages;
- Definition and management of a metadata set for Learning Resources, courses and/or curricula;
- Registration and login (to access metadata records);
- Manual content creation.

The second BETA release addressed the issues from the first BETA version and provided the following additional functionalities:

- Aggregation mechanism;
- Review process;
- PID schema;
- Versioning ;
- User profile.

The production version, available by month 18, and the at least two updates that will be made available until the end of the project, include and will integrate the comments from the pilots and tests and the following functionalities:

- Feedback mechanisms;
- Support for different languages.

The main developments in the KH Training Catalogue are related to the inclusion of training content with the registration of resources in the Training Catalogue. Further developments will be needed, of which we highlight the following:

- Display of landing pages of external training catalogues;
- Registration and login to access metadata records;
- Curation and review process (for training metadata);
- PID schema;
- User feedback workflow;
- User profile management;
- Integration of the Helpdesk ticket system;
- Identification and outreach to other potential catalogues that could be onboarded to KH;
- Possible further refinement of minimal metadata set in tandem with new work being conducted by RDA ETHRD Interest Group;
- Continue dialogue with the EOSC Association to ensure the long-term sustainability of the KH Training Catalogue.

4 Learning Platform

The Learning Platform comprise a Learning Management System (LMS) and an Authoring Tool. The main components of the LMS are an online learning environment with training courses, certification, a repository populated with openly available training resources, and a directory of trainers. It is an execution environment for interactive course resources and as such, any courses held in the Training Catalogue that are in the appropriate format can be run in it with minimal effort.

The initial objective was to build an in-house solution for the LMS of the Learning Platform. This solution was later re-evaluated in consideration of the quantity and variety of open source LMSs that could respond to the specific needs of EOSC and that are readily available.

4.1 Learning Management System

Task 9.3 therefore conducted a scoping exercise to determine whether any of these would fulfil our requirements and which one would be best for EOSC. Building on previous scoping exercises conducted for other EOSC initiatives, such as the EOSC Synergy project [12] , and integrating Task 9.3 own evaluations based on the specific requirements of the KH as highlighted in D9.1, the best option was deemed to be Moodle, as an open source, adaptable and user-friendly LMS that also ensures a degree of familiarity for end-users being a very well established and feature rich platform.

The choice of the LMS to adopt for the KH was done considering two different aspects: on the one hand, the need for a well-known, open source, user-friendly, reliable, secure and customisable platform that could suit the specific project needs, and on the other hand the analysis conducted on the same aspects by previous projects.

In this sense, importance was given especially to an extensive study conducted by EOSC Synergy[7] WP6 that examined both the most relevant available training platform as well as the solutions implemented by other projects, infrastructures, ESFRI cluster projects and INFRAEOSC-5b regional projects.

Additional considerations were also given to the latest developments in the online learning tools sector. After all these considerations, the decision was taken to adopt Moodle LMS as the fundamental platform for the project. Customisation of this openly available LMS is in progress.

Moreover, it was decided that instead of implementing a new instance of Moodle, it would be beneficial and in line with EOSC Future's principles to not re-invent anything (thereby reducing fragmentation) and to integrate with a pre-existing Moodle instance if possible. To this end, an open call was made to invite possible hosts for the EOSC KH. This resulted in one candidate, OpenPlato, which went on to become the host of choice.

4.1.1 Integration with OpenPlato

OpenPlato [13] is a recently implemented (June 2022) training platform based on Moodle and with its own bespoke resource catalogue. The platform is aimed at the open science and RDM community, and it is for this reason that it was put forward as a candidate to host the EOSC KH. Once the choice was made to integrate the EOSC KH into OpenPlato, efforts were made towards aligning the two systems.

4.1.2 AAI

Since OpenPlato is one of several services that has been established by OpenAIRE, it will be integrated with the same Authentication and Authorisation Infrastructure (AAI) that they use for single sign-on onto EOSC federated services.

4.1.3 Training Resources: Courses and Learning Paths

Moodle uses *categories* to define spaces in which thematically similar resources can be stored and deployed. It is with one such category that the EOSC KH has been created. Courses developed as part of T9.2 will be made available through this area and will be discoverable through the Training Catalogue described in Section 3.

[7] https://www.eosc-synergy.eu/

Moreover, courses will be sequenced where applicable to create learning paths for predefined user journeys and which have been published on the public wiki [14] and will undergo further development.

4.2 Authoring Tool

Somehow separate, yet strongly related, from the issue of a KH hosting solution is the identification of a tool to create e-learning resources, the so-called authoring tool. An authoring tool in fact, allows content creation, while the Learning Management System (LMS) hosts this learning content.

Authoring tools therefore, with their diverse functionalities and allowing a variety of development options, bring an added value to learning products as they provide the possibility to diversify the learning experience while at the same time to create learning contents that are engaging for final users. Rather than just offering learners simple text documents or Powerpoint slides, an authoring tool allows one to expand the horizons of a training product by leveraging different types of multimedia content and different levels of interactivity. An authoring tool in fact, frequently also includes storyboarding and editing features that allows for the creation and combination of different elements within an eLearning course (text, video, audio, graphics and animations).

Moreover, an authoring tool also permits to generate a variety of outputs and versions of SCORM or xAPI, two standards commonly used in the learning and training sector that ensure communication and interoperability between an LMS and an authoring tool, enabling the inclusion of different types of media in learning and training contents. SCORM Compliant authoring tools for example, ensure that courses are packaged in a zip file that can be uploaded to the LMS.

This said, there are a myriad of authoring tools on the market that vary by typology, functionalities, usability, interactivity, complexity and, of course, cost. Their respective performances should therefore be evaluated on the basis of the specific needs of the training content authors, editors, and users as well as on the specific requirements of the LMS administrators.

4.2.1 Scoping Exercise and Selected Solution

For the analysis and selection of an authoring tool that could serve the specific needs of the EOSC KH and prospective users, the Task 9.3 considerations were based mainly on two aspects among all those mentioned above: the **purchase cost** (and in this sense both open source and commercial solutions were investigated), and the level of **complexity** and **usability/accessibility** of the tool.

Although the project was looking preferably for a solution that was open source, a number of aspects needed to be factored in for the final choice, namely: speed and efficiency of authoring (easy and quick to learn and navigate tool, ability to create learning contents in a relatively short time), quality of e-learning output, scalability and supported e-learning formats. Task 9.3 therefore agreed that the best line of action would be to undertake another scoping exercise of available options, examining strengths and weaknesses of both commercial and non-commercial products.

This analysis led to the selection of a commercial authoring tool produced by the software developer Articulate [15] as the best fit for EOSC needs in this task. Articulate has developed an authoring tool that allows creation of rich and dynamic learning resources while at the same time offering a solution that is good for those that are new to online learning content creation, given the ease of use vis-à-vis the potential offered.

Moreover, Articulate allows importing Microsoft Powerpoint presentation slides, among other things. Being able to import the slides means being able to reuse existing materials and transform them (or at least prepare them) into e-learning resources. Articulate also allows the creation of interactive quizzes by importing questionnaires from excel files, or directly creating multiple choice or other tests.

The software developed by Articulate offers different options: a standalone desktop application, Articulate Storyline [16] , as well as the web-based Rise 360 [17] , which is particularly suited to those who want to create e-learning content optimised for the mobile world. Rise 360 authoring is done entirely through any supported web browser (Firefox, Chrome, Safari, etc).

Both versions of Articulate were found to respond to all the identified EOSC KH needs: easy to use with a simple and intuitive interface; quick to create good-looking (relatively simple) e-learning content; little or no prior

experience with e-learning software required for authors to use it (provides a range of pre-built, standard interactions, including timelines, processes, labelled graphics, etc.); and scalability (e-learning courses can be cloned and reused to save time when working at scale).

The web-based version however, as a cloud-based option was in addition found to be easy to update, collaborate and review, promoting collaboration between multiple authors and/or stakeholders, supporting the most relevant output formats such as SCORM, AICC and xAPI (TinCan), and - as a plus - requiring no hosting of the tool itself as this is done on Articulate's servers. E-learning courses can then be exported to SCORM packages, the most common standard for such resources, and uploaded to a LMS such as Moodle for delivery of the content.

Additional features that were evaluated pertained to the quality of e-learning output, the speed and efficiency of authoring and the scalability. In terms of quality of the e-learning output, Articulate Storyline allows to author highly customised and engaging content but requires a fair amount of skills and competencies, whereas Rise 360 is really easy to use thanks to its intuitive interface and a range of pre-built standard interactions that make it easy to create interactive content that looks good. In terms of speed and efficiency of authoring it was observed that Articulate Storyline is a complex tool that requires training time otherwise authoring efficiency can be limited. Rise 360 on the other end, not requiring an experienced author, allows anyone to quickly create basic (in terms of interactivity) yet good-looking e-learning content by following a sequence of logical steps – starting from scratch or by picking a template. Finally, in terms of scalability, it was noted that Articulate Storyline, being a desktop tool naturally limits collaboration and therefore scalability as it makes it difficult to share courses with others for reuse. Using Rise 360 instead allows duplicating courses that can be then reused to save time when working at scale. Table 4.1 summarises respective strengths and weaknesses of the Articulate authoring tool in its two different variants.

Table 4.1: Articulate Authoring Tool Versions Strengths and Weaknesses

Articulate 360	Strengths	Weaknesses	Best for
Rise (web-based authoring tool)	• Easy to use with a simple and intuitive interface • Quick to create good-looking (relatively simple) e-learning content quickly • Screencasting available • Cloud-based – easy to update, collaborate and review	• Content can look very generic • Limited customization and flexibility • No translation management • Lacking in accessibility options • Storage limitations in place	• Authors with little or no prior experience with e-learning software • Basic 'no frills' templates • Quick content production • Collaboration between multiple authors and/or stakeholders
Storyline (desktop application)	• Good flexibility and control in terms of content output • A commonly used tool, so designers tend to have experience • Very active online community • Reasonably powerful show me/try me/test me software simulation e-learning capability	• Not truly mobile responsive – it just shrinks the screen • More traditional linear design compared to modern e-learning authoring tools • Collaboration and content updates can be time consuming • Don't get new features and bug fixes instantly • Can be very expensive if you have a lot of authors and want to scale content • Poor screen reader functionality	• Authors with experience • Producing highly-customised content • Extensive design capabilities • Flexible templates and design features

Considering all the above the preference to use Articulate Rise 360 was made, and two licences were acquired to share amongst the T9.2 group, who will be doing the content creation.

It should be noted that the choice of Articulate as an authoring tool is for internal purposes and will be made available upon request by external contributors, which will be reviewed. The use of other authoring tools is not negated, as long as they are able to produce outputs that can be uploaded to the LMS, i.e. SCORM packages.

4.3 IT Infrastructure

OpenPlato was initially built by ED-ROM [18] and is hosted by ICM [19] and currently has 2 TB of storage space with the ability to scale up when required and is part of a larger computing infrastructure. The platform itself is running Moodle v3.11.6 [20] over a 10Gb connection and has the ability to host 100 concurrent users and has successfully passed load tests. Maintenance of the hardware will be managed by ICM, while configuration, site admin and support will be conducted by OpenAIRE, after extensive support and training from ED-ROM. Daily backups of the platform are also undertaken to guarantee protection of the training resources stored on the platform. During normal working hours (Mon-Fri 09.00-17.00 CET) there will be full support available from a dedicated training and support team, with response times within 1 hour, while there will be best effort to support outside these times. There is a dedicated email address for support and there will be integration with a soon to be launched helpdesk based on Zammad [21] .

4.4 Release Plan

The first BETA release of the Learning Platform is planned to be realised by month 18. For this first phase the available functionalities will be:

- Learning Management System (LMS) – Users / Admin;
- E-learning authoring tool (technical specifications);
- Standards for e-learning object packages (technical specifications);
- Search Engine;
- Admin Dashboard.

The second BETA release (M19) will address the issues from the first BETA version and will provide the following additional functionalities:

- User Experience (UX);
- Learning Content Delivery and Learning Paths;
- Help Centre.

Production version will be made available by month 20 and at least two updates will be made available until the end of the project. For this phase the available additional functionalities will be:

- Trainers' Directory;
- Security (specifications).

The main developments in the KH Learning Platform are related to the inclusion of training content with the creation and availability of courses and learning paths on the learning platform (OpenPlato). Further developments will be needed, of which we highlight the following:

- User feedback workflow;
- User profile management;
- Identification and outreach to other potential catalogues whose learning resources could be onboarded to KH;
- Continue dialogue with the EOSC Association to ensure the long-term sustainability of the KH Learning Platform.

5 KERs

As part of an effort to more closely align with the aims of the EOSC Association [22] and to enable sustainability beyond the lifetime of the EOSC Future project, several key exploitable results (KERs) were identified across the project and one of which is the EOSC KH (KER 6). The following is a description of this KER and which will form the basis for future discussions with the EOSC Association:

"Seamlessly integrated with the EOSC Portal, the EOSC Knowledge Hub (KH) is a platform that delivers a highly curated training resources catalogue and a state-of-the-art Learning Management System (LMS) based on Moodle (for content delivery) and Articulate (for authoring). The catalogue focuses on free (as well as paid-for, where applicable) training content pertinent to EOSC, its services and related FAIR and Open Science concepts. By bringing together disparate sources of information, the KH acts as a centralised hub for training related to all things EOSC.

Through the creation of modularised CC-BY licensed training resources and promotion of reuse of those resources, the KH delivers tailored content to its users.

Key benefits/impact for EOSC

To provide a centralised, sustainable resource for all things training related for EOSC using a standardised metadata set that allows FAIR principles of training resources to be fulfilled. This will be a resource by the community and for the community."

Delivery of tailored content to users:

- 200 training providers registered in EOSC catalogue by M30;
- 600 trainers on EOSC Knowledge Hub by M30.

6 Conclusions

The development and implementation process for the two components of the EOSC Knowledge Hub, the Training Catalogue and Learning Platform, took place in the last 12 months of the current project and is now concluding with its release in Month 18. This follows the finalisation of the KH technical specifications as detailed in D9.1 at M6. The outcome is the result of a long, challenging, and complex effort conducted collaboratively by WP9, WP5 and WP7 and comes at the end of a holistic approach of revision, refinement, validation, and adjustment of the technical architecture that is behind the KH.

These actions proceeded in parallel for the Training Catalogue on one side and the Learning Platform on the other. As the primary entry point to the KH for end-users, the Training Catalogue development was given priority in the process. In this sense, Task 9.3 initiated a continuous dialogue and sharing of information via a series of periodic meetings with Task 5.3, who were mandated to undertake technical development of the KH. In these meetings, the D9.1 specifications were examined in-depth in order to clarify requirements, finetune the architecture, integrate the main EOSC Portal technical settings (as well as the wider EOSC environment aspects - both from the frontend and from the backend), adjust the overall technical architecture and prerequisites with the final aim to better address the specific needs and effectively respond to the learning requests of the EOSC community. This complex step, that in some cases required making compromises that could reconcile different approaches, visions and sensitivities, proved to be valuable as it allowed integrating all these different perspectives in the KH in order to create a final product that could efficiently address and fulfil a variety of requests from the various EOSC stakeholders. After this preliminary step, the technical development process got underway and was operated by T5.3, with sustained support and exchange from T9.3 and involvement of other interested stakeholders, to reach the result that is reported in the present document.

A similar process, with due differences, was implemented for the Learning Platform. However, due to the various analysis and scoping exercises which led to the revised decision of adopting an existing solution for the LMS and another solution for the authoring tool, the cross-WP discussions covered the technical architecture in terms of interoperability between the two components on the one side, and on the usability and licences allocation for the content providers.

During this time, the decision-making process for the KH hosting solution was a challenging aspect and one which consumed most of the time before the actual implementation. Due diligence was conducted, and a tender process was followed where prospective candidates could show their interest in becoming the KH host, while decision making was led by senior hierarchy in the EOSC Future project including the TCB. The eventual outcome was that OpenPlato was the only candidate, and it was authorised to become the KH host at the end of M16.

The EOSC Knowledge Hub version that the project is releasing in M18, and which will be further refined in many aspects and components, is therefore a version that constitutes a solid foundation for EOSC and its future progress.

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