

FAIRness and Openness audit framework report

ABSTRACT

The report on FAIRness and Openness is the result of the audit conducted on training material produced in PR3 and PR2 in order to strengthen the evidence-based approach adopted by the project and to demonstrate the impact of the CeOS_SE project in the open science framework

ABSTRACT

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Overview	
Document title	FAIRness and Openness audit framework report
Dissemination Level	Public
Date of completion	March 29, 2024
Type	Report
Version	1
Number of Pages	23

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Universitet Po Bibliotekoznanie Informacionni Tehnologii	Bulgaria	Partner



DOCUMENT HISTORY			
Version	Date	Description	Author
0.0	Oct.30, 2023	Outline of the content and structure	Elena Giglia, Giannis Tsakonas, Theodora Karaiskou
0.1	Jan. 3, 2024	First draft of the reference materials	Elena Giglia
0.2	Jan. 30, 2024	First draft finished; comments requested	Elena Giglia, all partners
0.3	Feb. 29, 2024	Checks needed from all partners	Elena Giglia, all partners
1	March 29, 2024	Check inserted into matrices; final version finalized	Elena Giglia



FAIRness and Openness audit Framework - CEOS_SE PR5A3

Summary

1. Reference material	5
1.1. The ten rules	5
1.2. Methodology for FAIR-by-Design Training Materials	10
1.3. Recommendations for a minimal metadata set to aid harmonised discovery of learning resources	12
1.4. ELIXIR FAIR training handbook	15
2. CEOS_SE suggested matrices - check	16
MATRIX A - TEN SIMPLE RULES	16
MATRIX B - FAIR LEARNING OBJECTS	17
MATRIX C - MINIMAL METADATA SET	19
MATRIX D - SUGGESTIONS FROM THE ELIXIR FAIR TRAINING HANDBOOK	19
3. CEOS_SE suggested matrices - checks and improvements made	20
4. Conclusions	22



1. Reference material

Even though some of the CEOS_SE outputs are not all labelled as “training material”, many activities carried out during the project were training sessions and/or the reports of the events had an implicit reuse purpose to show other libraries lessons learned and to suggest methods and formats.

Hence, some reference sources focused on training material were identified, to be adapted and used to assess the FAIRness and Openness of the project:

- **R1:** Garcia L, Batut B, Burke ML, Kuzak M, Psomopoulos F, Arcila R, et al. (2020) **Ten simple rules for making training materials FAIR**. PLoS Comput Biol 16(5): e1007854. <https://doi.org/10.1371/journal.pcbi.1007854>
- **R2:** Filiposka, S., Green, D., Mishev, A., Kjorveziroski, V., Corleto, A., Napolitano, E., Paolini, G., Di Giorgio, S., Janik, J., Schirru, L., Gingold, A., Hadrossek, C., Souyioultzoglou, I., Leister, C., Pavone, G., Sharma, S., Mendez Rodriguez, E. M., & Lazzeri, E. (2023). D2.2 **Methodology for FAIR-by-Design Training Materials** (1.4). Zenodo. <https://zenodo.org/doi/10.5281/zenodo.8305539>
- **R3:** Hoebelheinrich, N. J., Biernacka, K., Brazas, M., Castro, L. J., Fiore, N., Hellström, M., Lazzeri, E., Leenarts, E., Martinez Lavanchy, P. M., Newbold, E., Nurnberger, A., Plomp, E., Vaira, L., van Gelder, C. W. G., & Whyte, A. (2022). **Recommendations for a minimal metadata set to aid harmonised discovery of learning resources** (Version 1.0). Research Data Alliance. <https://doi.org/10.15497/RDA00073>
- **R4:** ELIXIR **FAIR training handbook**, <https://elixir-europe-training.github.io/ELIXIR-TrP-FAIR-training-handbook/>

Making use of these reference materials is a fruitful exercise not only to assess the FAIRness and Openness of CEOS_SE outputs but, more widely, to reflect on CEOS_SE journey and to learn lessons for the future - lessons which can be useful for any library.

1.1. The ten rules

The ten simple rules listed by Garcia et al. (R1) constitute the basis for the suggested Matrix A. The rules are summarized in the following image:



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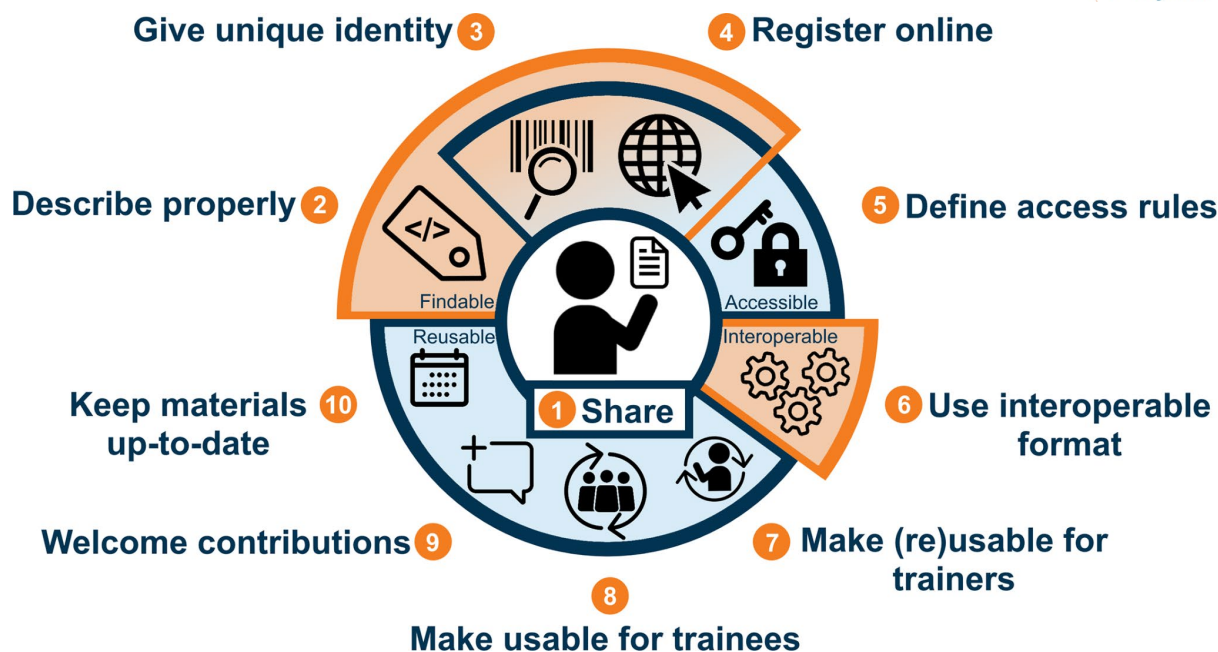


Figure 1: Ten simple rules for making training materials FAIR.

The text of the rule is highlighted in blue; reflections relevant for CEOS_SE in plain black text.

Not all the rules are applicable to any CEOS_SE output (e.g. for reports); however, they are useful to reflect on the following points.

Rule 1: Plan to share your training materials online

As a trainer, you are likely to be a passionate teacher and keen to share your expertise. Sharing your materials is one way to achieve this, a simple step that can bring many benefits:

- For you, it provides a record (and recognition) of the training that you have developed
- For other trainers, it can provide inspiration, in terms of the content covered and method of delivery
- For trainees, it provides a navigable landscape in which to find relevant training resources and build personalized learning paths
- For the bioinformatics community, it facilitates systematic training-gap analyses and development of additional materials and courses¹.

CEOS_SE planned to deposit all the outputs in Zenodo (<https://zenodo.org/>), setting the default to “Open”. Reusability has been the project approach since the planning of the proposal, as stated in the Data Management Plan (<https://doi.org/10.5281/zenodo.10909318>).

Rule 2: Improve findability of your training materials by properly describing them

¹ Original text of the Rules highlighted in blue.



Describing digital objects with structured metadata is fundamental to making them FAIR. Regardless of the type of object, adding appropriate, standardized metadata will help make them both machine and human readable. Metadata can be hosted outside the digital object itself, boosting findability and preserving information, even when the digital object has ceased to exist.

CEOS_SE choice of Zenodo as repository implies adopting its metadata schema, based on Data Cite metadata schema and exposed via JSON (see <https://about.zenodo.org/policies/> ; <https://about.zenodo.org/infrastructure/> ; <https://about.zenodo.org/principles/>).

Describing and annotating training materials with relevant keywords from controlled vocabularies, taxonomies, thesauruses, or ontologies is also important. This reduces ambiguity and facilitates discovery and retrieval of information by improving the efficacy of metadata filtering.

This was not foreseen, and can be improved, for instance by using the JITA classification system for Library and Information system (<http://eprints.rclis.org/view/subjects/subjects.html>).

Rule 3: Give your training materials a unique identity

A PID is a unique identification code that is attached to a digital object and registered at an agreed location. It is guaranteed to remain functional, even if an organization's URL changes. Providing PIDs for training materials makes them easier to cite and helps research-metric systems to count those citations.

The choice of Zenodo as CEOS_SE repository responds to this need. Zenodo assigns DOIs to any version uploaded.

Rule 4: Register your training materials online

To make your materials more discoverable, it is helpful to share them via an online registry that targets a specific audience (e.g., bioinformatics, physics, etc.).

The rule applies to specific domain repositories or specific OER (Open Educational Resources) ones and focuses on training materials. Zenodo as a general repository is suitable for the different outputs of the CEOS-SE project.

Rule 5: Define access rules for your training materials

Accessibility refers to the ability to retrieve content. Access to training materials may be open or limited via an access-request mechanism: authentication may be required owing to membership (i.e., a website's content may be limited to members), restricted domains (e.g., those available only for students in a particular university), or paid options (i.e., content is only available for a fee).



In CEOS_SE the default was set to “open”, following the principle “as open as possible, as closed as necessary”.

Only material with sensitive data such as surveys is kept closed.

Rule 6: Use an interoperable format for your training materials

Training materials need to be captured in interoperable formats, so that they can be used in different contexts (e.g., operating systems and software) and built upon later.

For materials like slides, it is important that other trainers are able to (re)use, fine-tune or even extend them.

The following table shows pros and cons of different formats, including the de facto standard used by many trainers (Power point presentations):

Format	Advantages	Disadvantages
PPT and PPTX	<ul style="list-style-type: none">• Easily (re)usable• Available to multiple OSs/Software• Widespread	<ul style="list-style-type: none">• Limited way to provide detailed training instructions• Not version controlled
Keynote	<ul style="list-style-type: none">• Polished overall aesthetic	<ul style="list-style-type: none">• Limited to macOS family• Not version controlled
PDF	<ul style="list-style-type: none">• Can be displayed identically in any environment	<ul style="list-style-type: none">• Not easily editable• Not version controlled
TeX	<ul style="list-style-type: none">• Easily editable• Version controlled• Free	<ul style="list-style-type: none">• Steep learning curve for trainers
MD, RST, and HTML	<ul style="list-style-type: none">• Version controlled Free	<ul style="list-style-type: none">• Rendering (need templating to transform into HTML)
Google slides	<ul style="list-style-type: none">• Version controlled Free	<ul style="list-style-type: none">• Not always possible to use owing to local/ institutional policies• Not always accessible (depending on geographic location)

MD, Markdown; PDF, Portable Document Format; PPT, PowerPoint; PPTX, PowerPoint Open XML Presentation; RST, reStructuredText

<https://doi.org/10.1371/journal.pcbi.1007854.t001>

Table 2 - interoperable formats

CEOS_SE outputs are available both in Powerpoint and in pdf, trying to avoid some of the disadvantages. Using Zenodo as a repository also enables version tracking.

Rule 7: Make your training materials (re)usable for trainers

Training materials can be made easier for others to (re)use and adapt by applying an appropriate license and annotating them with metadata.

Using a CC-BY license will ensure wider reuse.

Metadata should follow this schema:



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Type of metadata	What to include
Title	Title of the training material.
Contact details	Author(s) name and contact details.
Licensing and (re)use details	License under which the materials are shared, and rules and conditions for (re)use and contribution.
Preferred citation	Instructions on how to cite your material.
Description	Overview of the subject matter, aims of the training, and language in which the training is delivered.
Learning outcomes	Statements that indicate what trainees should be able to do upon successful completion of the training.
Target audience	The intended audience, their prerequisite knowledge and skills, their general background, and how the training material will help them.
Required resources	Technical resources and related materials (software requirements, datasets, infrastructure requirements, etc.).
Keyword	Keywords or tags identifying the topic of the materials.
Structure and duration	Description of the structure of the materials and setting in which to deliver them, including the time allocated to each part (lectures, exercises, etc.)
Additional information	Items that provide additional information about (re)use and delivery of the materials (e.g., general tips and guidance).
Links and references	Links and references that are relevant to the content but not required for delivery of the materials.
Date of last revision	Date of last update of the materials and the version.

<https://doi.org/10.1371/journal.pcbi.1007854.t002>

Table 3: metadata schema for training materials

CEOS_SE materials will try to adopt this schema integrating the existing information in the relevant Zenodo records.

Rule 8: Make your training materials usable for trainees

Describing the training materials with the schema suggested in Rule 7 will help trainees identify the most suitable training for them. Using a structured approach to articulate prerequisites, target audience, and learning outcomes helps to clarify which trainees will benefit most from the training, the skills they should possess before enrolling on a course or working through a set of materials, and what they can expect to be able to do upon successful completion of their training.

This was not foreseen and should be added to the training material on Zenodo.

Rule 9: Make your training materials contribution friendly

The rule applies only to CEOS_SE training materials. Whenever using or reusing training materials, it's useful to provide feedback on the content (e.g., by reporting errors, adding examples, or suggesting alternative explanations). Rules for participation and contribution should be stated, too.

It was not foreseen but at least a contact email can be provided in Zenodo on the material landing page.



Rule 10: Keep your training materials up-to-date

It is important to update your training materials and to keep abreast of current trends, new features, or developments in the field (new databases releases, software versions, etc.). When and how often to update your materials will depend on how frequently the resources or computational methods they describe change, whether new exercises or supporting media can be found to add a hint of freshness, and so on. If using screenshots to illustrate particular resources, they should reflect the current versions; similarly, exercises and answers should still work with current releases. Ideally, updated materials should be timestamped, given new PIDs, and added to a specialized online registry; for completeness, old versions should also be archived. If you no longer plan to update your materials, provide the timestamp of the last update.

The rule applies mainly to CEOS_SE training material, as the event reports are static by nature. Updating the training material presented during the LTTA event in Zagreb (Sept. 2022) was not foreseen - there are no hours in the project allocated to do that, but it can be a useful recommendation to be taken into account in planning and drafting for future projects.

1.2. Methodology for FAIR-by-Design Training Materials

The *Methodology* provided by the SKILLS4EOSC project is important as an approach. In the *Introduction* we read about the benefits of making learning materials FAIR, which can resonate to the CEOS_SE, as we live in the EOSC era:

The benefits of focusing on the development of FAIR learning materials go beyond the long-term investment for the EOSC training community including other aspects such as:

- Expanded base of learners

- Encompassing not just targeted trainees or OS students, but any interested party that would like to use the provided learning material, thus not only supporting, but actively boosting lifelong learning experiences;

- Improved learning process

- As FAIR learning materials mean that learners can easily find and access learning content, obtain more in-depth understanding of an offered course or training before actual enrolment, or go back to refresh their knowledge on a given topic;

- High-quality learning materials

- FAIR learning resources can be adapted and revised, and in this way more easily kept up to date, translated and localized to a specific context;
- The metadata that accompanies the learning materials offers clear information regarding licensing fostering reuse through adaptation and development of enhanced learning content;
- Existing learning resources can be revised and reused to build various learning aggregations such as learning paths or certification requirements;

- Sustainable education



- By integrating FAIR practices, educational institutions contribute to a more sustainable educational ecosystem. Reducing redundancy, maximizing resource utilization, and embracing openness support the efficient use of educational resources.
- **Scalability and efficiency**
- FAIR materials can be easily distributed and shared, allowing educational institutions and organizations to scale their educational offerings more efficiently.
- **Consolidated network of instructors**
- Trainers and teachers can create or review learning materials in a collaborative fashion.

Additional useful reflections come in the form of challenges

- **Finding existing FAIR learning materials on a given topic**
Many initiatives and parallel activities regarding OS and EOSC training/learning materials need to be aligned and harmonized. This process should focus on the produced initial body of available learning materials currently scattered on different platforms and repositories. Providing a single point for searching and accessing learning materials is still an open issue that is currently being tackled by projects such as EOSC Future [R6];
- **Learning materials formats**
Most of the available learning materials can be found in closed formats making them difficult to be reused by other instructors, especially when adaptation is needed. Also, the available content is mostly slide handouts, video recordings of webinars or short packaged courses, while the accompanying material such as exercises, quizzes, instructional guides, etc. are difficult to find or extract;
- **Extra effort**
It is clear that making learning materials FAIR adds a considerable overhead on the already lengthy process of development of new learning resources. Thus, awareness is needed that additional time and competencies are required when aiming to produce high-quality FAIR learning materials with enough granularity to ensure maximum re-usability.

The main point of reflection here is about closed formats, which make the material not immediately reusable by others.

As the document points out, FAIRifying existing materials can be time consuming and resource intensive, hence, the reflection can apply only to the design of future materials on the topics of the CEOS_SE project.

CEOS_SE partners should be aware of the new FAIR-by-design methodology for future outputs, even though it is not completely applicable to pre-existing materials such as those created during the project.

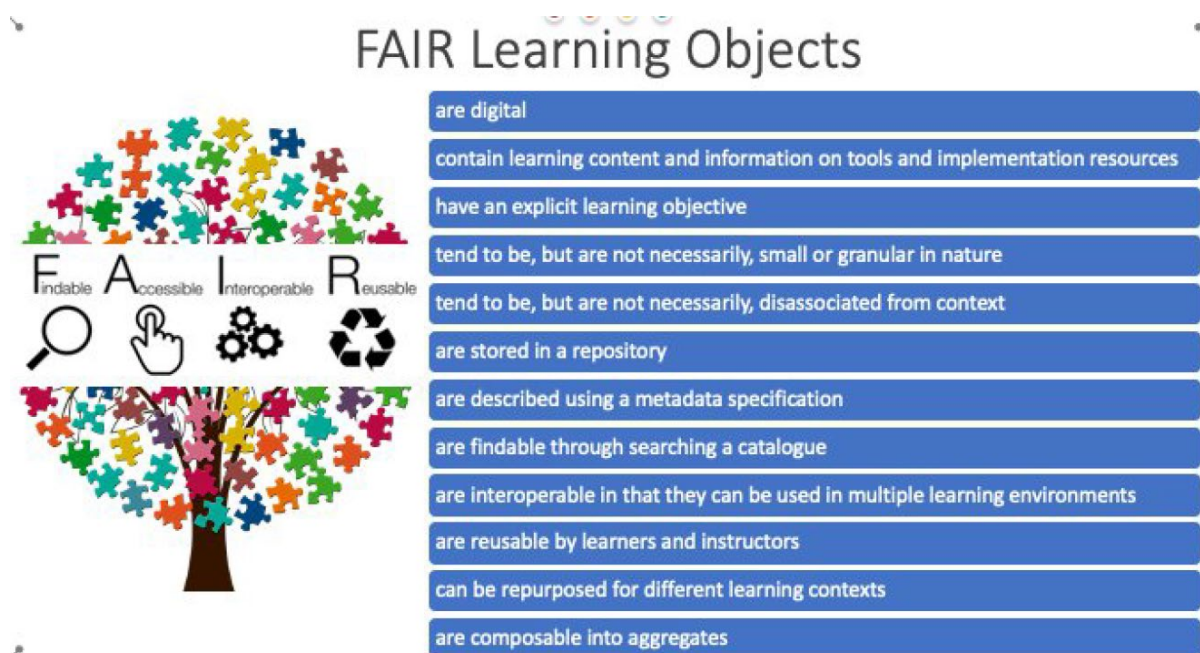
It's interesting also to see how FAIR principles can be applied to learning materials:

- **Findable** – the learning object is the lowest hierarchical level of findability of learning materials in the EOSC ecosystem and is thus the lowest hierarchical level that can be described with metadata and catalogued;



- **Accessible** – the full scope (content, tools and implementation resources) of the learning object should be accessible to both learning producers and consumers in the EOSC ecosystem;
- **Interoperable** – with a well-chosen scope (content, tools and implementation resources), the learning object can be consumed on multiple platforms;
- **Re-usable** – each learning object can be put in a wider context based on the specific learning requirements of a particular aggregate course, unit or module in the EOSC ecosystem.

The figure describing the FAIR Learning Object (page 26) can be checked against the CEOS_SE training materials:



<https://zenodo.org/doi/10.5281/zenodo.8305539>

Table 4: FAIR in training objects

Point 4.1.7 of the report (page 75), about Continuous Improvement, is understandably important for training material but unfortunately is not possible or foreseen due to the nature itself of CEOS_SE as a project, with limited funding and time span.

1.3. Recommendations for a minimal metadata set to aid harmonised discovery of learning resources

This Research Data Alliance - RDA Recommendation can be useful to check the FAIRness of CEOS_SE outputs because of its vision:



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The vision for the minimal metadata Focus Group is to develop a core set that can be recommended as a means to:

- facilitate discovery across catalogues and other resources
- provide utility for different points of view by targeting
 - resource searchers e.g. learners,
 - resource creators e.g. trainers
 - resource aggregators e.g. (training) service providers
- improve interoperability between learning resource catalogues
- work towards establishing best practice in applying FAIR principles to learning resources
- provide a foundation for the work of the products from the other Focus Groups

RDA proposed the following schema:

Element Name	Definition
Title	The human readable name of the resource.
Abstract / Description	A brief synopsis about or description of the learning resource.
Author(s)	Name of entity(ies) authoring the resource.
Primary Language	Language in which the resource was originally published or made available.
Keyword(s)	Keywords or tags used to describe the resource.
License	A license document that applies to this content, typically indicated by URL
Version Date	Version date for the most recently published or broadcast resource.



URL to Resource	URL that resolves to the learning resource or to a "landing page" the resource that contains important contextual information in the direct resolvable link to the resource, if applicable.
Resource URL Type	Designation of the identifier scheme used for the resource e.g., DOI, ARK, Handle.
Target Group (Audience)	Principal users(s) for which the resource was designed.
Learning Resource Type	The predominant type or kind that characterizes the learning resource.
Learning Outcome	Descriptions of what knowledge, skills or abilities a learner should acquire on completion of the resource.
Access Cost	Access cost: Choice stating whether or not there is a fee for use of the resource (CV = Y/N/Maybe with recommendation that further explanation of "Maybe" goes in the Description field for "It depends" or "It changes" explanations).
Expertise (Skill) Level	Target skill level in the topic being taught; example values include: beginner, intermediate, advanced.

Table 5: RDA minimal metadata set

The schema is available also in a detailed table at <https://www.rd-alliance.org/system/files/Copy%20of%20Examples%20for%20Professional%20and%20Informal%20Education.pdf>, which gives also examples of allowed values for each field. As in Zenodo (which is the CEOS_SE selected repository) the metadata set associated to the type "Lesson" does not include all the above, the partners decided to include a table within each training material record Description field showing "Learning resource type", "Targeted audience", "Expertise level", "Learning objectives".

Another interesting suggestion for further reflection is about controlled vocabularies, as they should be appropriate for a specific target group. As reported in the RDA Recommendation, UK JISC had identified several considerations in choosing controlled vocabularies:

- Your users - are the terms used going to be meaningful to them?
- The nature and extent of your collection - if your collection is small, you're unlikely to need a highly detailed vocabulary
- The skills and available time of your cataloguing staff - some of these vocabularies will require experience or training to use properly
- Your community - it makes good sense to use vocabularies that similar collections are using
- Copyright issues - you may need to check whether permission or a license is required to use the vocabulary in the way you wish to

CEOS_SE partners can engage in discussion over the most suitable controlled vocabulary for their target audience.



1.4. ELIXIR FAIR training handbook

The FAIR training Handbook is a valuable resource to trigger reflections on training materials but all in all on the entire CEOS_SE outputs, as shown in Matrix D.

Let's consider the following checklist (#2 in the Handbook):

2.1 Choose a format (Google slides, Google Docs, text files, including .md files, data files, image formats) for your training material that will facilitate FAIRness, i.e. others (and you) can edit, extend, modify without the need of proprietary tools.

2.2 Provide information with the material that explains its purpose, how the material should be used (for self-learning, in classroom teaching) and delivered (mode of delivery), add a lesson plan - any information that will help other trainers to reuse it.

This could be helpful not only for the training material but also, somehow, for the reports on the Learning by doing or the Train the trainers activities, in explaining how they can be replicated by others. Again, as it was not foreseen at the beginning, it will be on the to-do list for future projects.

Addressing FAIRness, the handbook suggests

1. Findable: the use of identifiers (DOIs for objects, ORCIDs for authors) [see chapter 5]
2. Accessible: the use of standard protocols to share the materials; the access policy set to "Open" [chapter 6]
3. Reusable: use the metadata adopted by your community, and describe the material in the richest possible way to enable reusability [chapter 7]; assign proper license [chapter 8]

In the checklist there is also another useful suggestion, which CEOS_SE adopted from the beginning by creating its own Community in Zenodo:

3.1 Choose a platform (Google Suite, GitHub and GitLab, Zenodo, Learning Management systems) that will facilitate maintenance and collaboration through the whole life cycle of your training materials.

The initial Handbook consideration can be used by CEOS_SE partners as an overall reflection:

- What training materials do you have?
- Who are you FAIRifying them for?
- What resourcing, capabilities and capacity do you have?
- Are there institutional or regulatory considerations?



2. CEOS_SE suggested matrices - check

Based on the suggested reference material, different checks (and reflections) can be conducted using different matrices.

MATRIX A - TEN SIMPLE RULES

	RULE	TO BE CHECKED AGAINST	SCORE	IMPROVEMENT NEEDED?
A1	Rule 1: Plan to share your training materials online	On all materials: - is the default set to "open"?	Yes	
A2	Rule 2: Improve findability of your training materials by properly describing them	On all materials - is there a standard metadata schema? - are there controlled vocabularies in use?	Metadata schema: DataCite (by Zenodo) Controlled vocabularies: not yet	Suggestion: adopt JITA when suitable (http://eprints.rclis.org/view/subjects/subjects.html)
A3	Rule 3: Give your training materials a unique identity	On all materials - is a DOI available for any version of the outputs? - are they ORCID ID for authors?	DOI: YES ORCID: not always	ORCID ID must be added on Zenodo
A4	Rule 4: Register your training materials online	On all materials - is the output available on Zenodo? - is the Type (e.g."Lesson") correct?	Yes	
A5	Rule 5: Define access rules for your training materials	On all materials - is the principle "as open as possible" applied?	Yes, see the project DMP	
A6	Rule 6: Use an interoperable format for your training materials	On all materials - balance advantages and disadvantages of the common used formats (see table 2)	Somehow Yes. Powerpoint and pdf are available, to mitigate the disadvantage	Reflect for the future if it's not too time consuming adopting different, more interoperable



			es of both	formats (e.g. TeX?)
A7	Rule 7: Make your training materials (re)usable for trainers	On all material - licence to reuse	Licenses: CC_BY was chosen as the default Metadata: Not all the fields are present	Metadata to be added on Zenodo records for training materials at least
A8	Rule 8: Make your training materials usable for trainees	On training material only - are prerequisites, target audience, learning outcomes clearly stated (also in metadata)?	No	To be added on the Zenodo records
A9	Rule 9: Make your training materials contribution friendly	On training material only - is there a way to give feedback? - is there a way to collaborate/contribute?	Not foreseen	At least contact email to be added on Zenodo landing page
A10	Rule 10: Keep your training materials up-to-date	On training material only - update screenshots - update reference to official documents, policies, software release...	Not foreseen	To be planned in future project drafting (specific tasks)

MATRIX B - FAIR LEARNING OBJECTS

	CHARACTERISTICS	TO BE CHECKED AGAINST	RESULTS	IMPROVEMENT NEEDED/USEFUL FOR FUTURE REFLECTIONS
B1	Are they digital?	All the material	YES, deposited in Zenodo	
B2	Do they contain learning content and information on tools and	All the material, applicable also to Learning by doing	NO	Information needs to be added to Zenodo



	implementation resources?	reports		at least for type "Lesson"
B3	Do they have an explicit learning objective?	Training material	NO	Information needs to be added to Zenodo at least for type "Lesson"
B4	Do they tend to be, but are not necessarily, small or granular in nature?	Not applicable, CEOS_SE is not producing learning courses but only stand-alone training materials		
B5	Do they tend to be, but are not necessarily, disassociated from context?	Not applicable. CEOS_SE material is all based on regional and local contexts		
B6	Are they stored in a repository?	All materials	YES, Zenodo CEOS_SE community	
B7	Are they described using a metadata specification?	All materials	YES, using Zenodo metadata schema	
B8	Are they findable through searching a catalogue?	Mainly training materials	No, we choose to have all the project materials in the Zenodo community not to disperse them	
B9	Are they interoperable in that they can be used in multiple learning environments?	Mainly training materials	A pdf version is uploaded in Zenodo to ensure readability; for reuse a ppt version is provided	
B10	Are they reusable by both other instructors and learners?	Only on training materials	A pdf version is uploaded in Zenodo. to ensure readability; for reuse a ppt version is provided	
B11	Can they be repurposed	Not applicable		



	for different learning contexts?			
B12	Can they be composable into aggregates?	Not applicable		

MATRIX C - MINIMAL METADATA SET

	ELEMENT NAME	PRESENT IN ZENODO Y/N	HOW TO IMPROVE
C1	Title	YES	
C2	Abstract/description	YES	
C3	Author	YES	
C4	Primary language	YES	
C5	Keyword(s)	YES	
C6	License	YES	
C7	Version date	YES	
C8	URL to resource	YES	
C9	Resource URL type	YES	
C10	Target group	NOT IN METADATA	AT LEAST ADD A TABLE WITH THESE ELEMENTS IN THE DESCRIPTION
C11	Learning resource type	NOT IN METADATA	AT LEAST ADD A TABLE WITH THESE ELEMENTS IN THE DESCRIPTION
C12	Learning outcome	NOT IN METADATA	AT LEAST ADD A TABLE WITH THESE ELEMENTS IN THE DESCRIPTION
C13	Access cost	NOT IN METADATA	AT LEAST ADD A TABLE WITH THESE ELEMENTS IN THE DESCRIPTION
C14	Expertise (skill) level	NOT IN METADATA	AT LEAST ADD A TABLE WITH THESE ELEMENTS IN THE DESCRIPTION

MATRIX D - SUGGESTIONS FROM THE ELIXIR FAIR TRAINING HANDBOOK



	CHARACTERISTIC	VERIFIED? yes/no	IMPROVEMENT NEEDED
D1	<p>FORMAT are you using a format that will facilitate FAIRness, i.e. others (and you) can edit, extend, modify without the need of proprietary tools.</p>	<p>To a certain extent. A pdf version is uploaded in Zenodo. to ensure readability; for reuse a ppt version is provided - but it is still a proprietary format</p>	<p>For future projects consider using GitHub, TeX</p>
D2	<p>INFORMATION Do you explain the purpose, how the material should be used and delivered and add a lesson plan - any information that will help other trainers to reuse it.</p>	<p>Not present - but very useful to be added to future outputs</p>	<p>Some of these elements are present in the table to be added to the Description field</p>
D3	<p>IDENTIFIERS: Are you using DOIs? Are you using ORCIDs?</p>	<p>See Table XXX DOI:YES ORCID:Not always</p>	<p>ORCID to be added</p>
D4	<p>ACCESS: Is the material Open? Did you choose a platform enabling discovery and access? Is it suitable for people with special requirements (e.g.visual ones)?</p>	<p>YES for Findability No for impaired people access</p>	<p>For future projects. think about readable characters and other impaired people tools</p>
D5	<p>REUSE: Is the material described in the richest way? Are there licenses associated to the material?</p>	<p>Licenses: YES Descriptions: to be improved</p>	
D6	<p>WHO are you FAIRifying the material for?</p>	<p>Not explicit - however, the scope of the project is broad, so maximum reuse is foreseen. The use of national languages also helps reuse by national reusers</p>	<p>Suggestion: it might be useful in future project to add a Reuse section in the Description field</p>

3. CEOS_SE suggested matrices - checks and improvements made

As a general result of the audit, the materials produced in CEOS_SE are compliant to a large extent with the FAIR principles adapted to training and learning materials.



After checking based upon the suggestions of the reference sources listed in paragraph 1, some improvements were made on the CEOS_SE outputs, namely:

Based on	Action suggested	CEOS_SE output	Improvement made [specify to which of the FAIR principles it refers]
A3, D3	Adding ORCID IDs	All the ones in Zenodo missing an ORCID now have one	F- Findable For authors to be identified
A3, D3	Adding training materials deposited only in local repositories to Zenodo	Added to Zenodo	F-Findable get a DOI
A8, B3, C10-14, D2	Adding (at least in the Description field) Learning objectives, targeted audience...	All the material in Zenodo	R - Reusable
D1	To be added in future projects	[Not applicable yet]	A-Accessible
D4	To be added in future projects	[Not applicable yet]	A-Accessible
A9	To be added in future projects	[Not applicable yet]	R- Reusable
A10	To be added in future projects	[Not applicable yet]	R-Reusable



4. Conclusions

The Audit on FAIRness and Openness turned out to be a fruitful exercise not only to be sure that the materials produced in CEOS_SE was “as FAIR as possible” to be embedded in the Open Science/EOSC landscape but also to reflect on potentially adopting recommended practices, formats and standards in future projects involving learning materials.

Some of the rules or suggestions coming from the Reference materials listed in par. 1 were applicable only to Learning Objects as components of complex training courses, whereas CEOS_SE materials were often used in stand-alone events.

Even though some of the rules or suggestions were overlapping, all in all they provided a useful reflection framework and triggered some improvements.

The choice of Zenodo as the preferred venue to deposit all the project outputs on one hand made the FAIRification easiest due to its adherence to the principles; on the other hand, not being Zenodo a repository designed specifically for training material we faced a lack of specific metadata fields (e.g. targeted audience, expertise level) which we manage to add in the Description field. It is a sub-optimal solution, but we prioritized having all the project outputs in one collection instead of dispersing it in different repositories, even when more tailored for specific materials.

The effects of the Audit will be, for sure, evident also on the training materials created by the CEOS_SE partners in the future, as it created awareness on specific FAIR implementation for these peculiar digital objects.

