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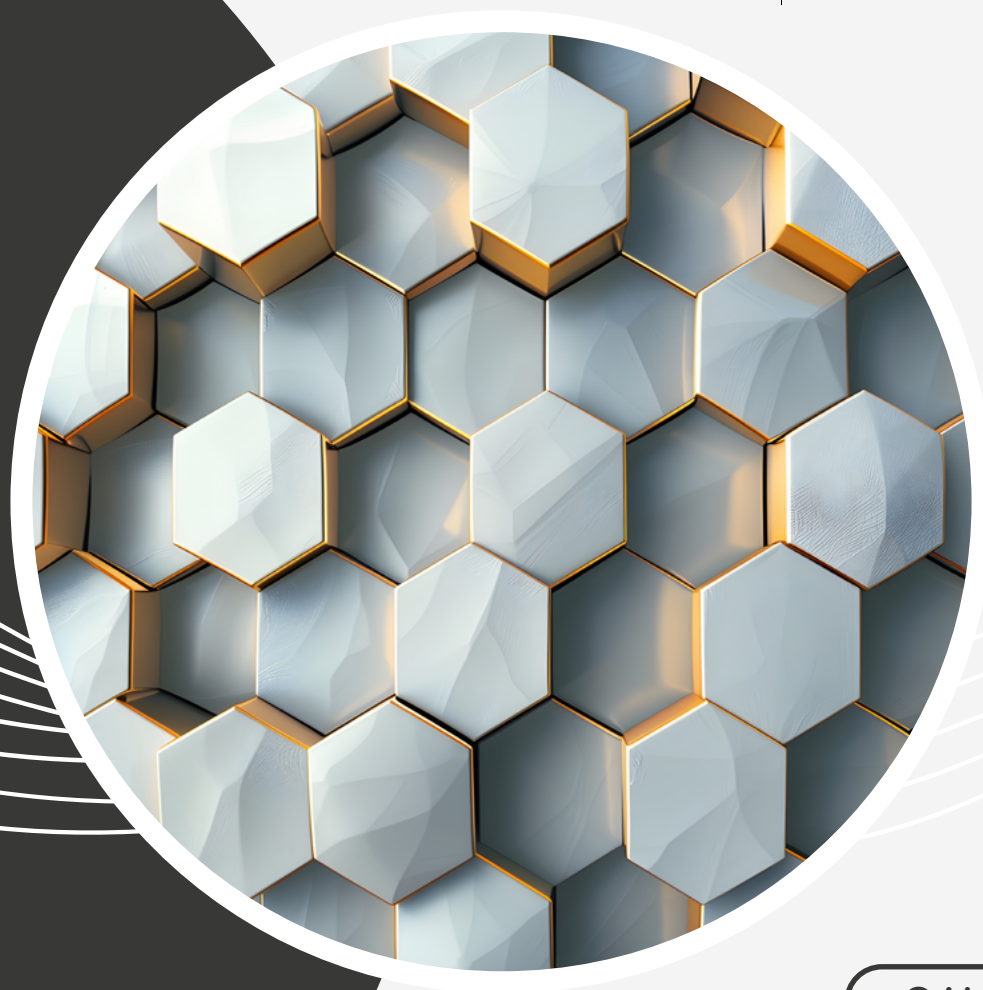
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co-funded by
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QUICK GUIDE



FAIR-by-Design Methodology for learning materials



FAIR-by-Design Methodology for learning materials

Version 1.0 (January 2025)

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Disclaimer

This is a digest of Deliverable “**D2.2 Methodology for FAIR-by-Design Training Materials**” (<https://zenodo.org/records/8305540>) and was produced by the Skills4EOSC project. The project has received funding from the European Union’s Horizon Europe research and innovation Programme under Grant Agreement No. 101058527 and from UK Research and Innovation (UKRI) under the UK government’s Horizon Europe funding guarantee [grant number 10040140].

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DOI link

<https://doi.org/10.5281/zenodo.14711525>

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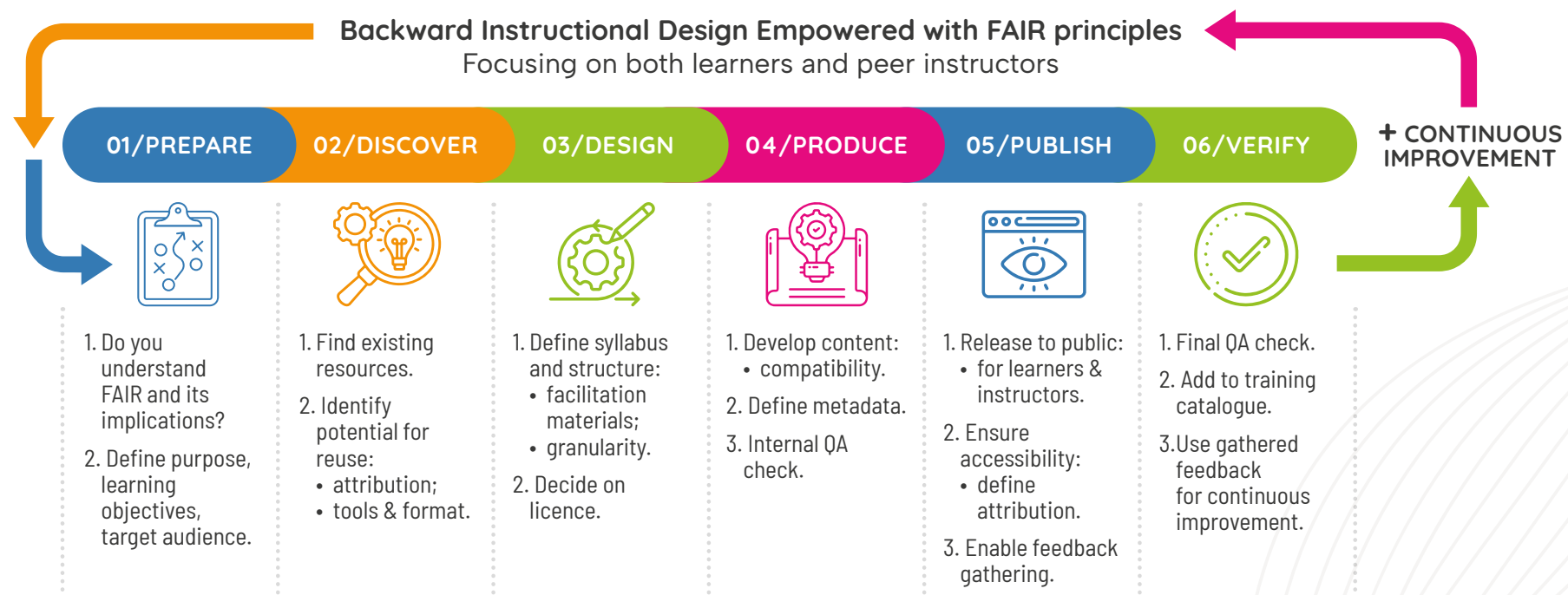
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Summary

Training is vital for the European Open Science Cloud (EOSC) to succeed as key EU Open Science research meta-infrastructure. It tackles the challenge of upskilling a large community of various stakeholders with the necessary competences to both build and use data and services. It is therefore important that the EOSC training community is able to efficiently collaborate ensuring the delivery of high-quality up-to-date trainings and learning opportunities. To help achieve this goal, Task 3 of Work Package 2 within the Skills4EOSC project has produced a methodology for developing FAIR-by-Design learning materials that will ensure maximum reusability of developed learning materials within the community and higher-quality materials.

FAIR-by-Design Methodology





The proposed methodology builds on the previous work done in other EOSC projects, while incorporating best practices and lessons learnt from related activities such as implementation of learning platforms, development of self-paced courses, definitions of metadata schemas for training materials and integration of training catalogues. All necessary steps to ensure the production of FAIR-by-Design learning materials are outlined in a six-stage workflow that extends the traditional instructional design process with additional activities aiming to incorporate within the FAIR principles.

Each stage of the workflow discusses the relevant aspects of learning material development blending learning models, materials and methods with the FAIR requirements. In this way an efficient, lean approach is proposed for instructors that are guided through each step of the design process helping them expand their instructional design skillset with FAIR relevant competencies.

The workflow stages also include a number of quality assurance checkpoints together with the activities on defining and handling feedback from different stakeholders supporting the process of co-creation of the learning materials with other peers. The complete process encompasses the principles for continuous improvements where the gathered feedback can be fed back to the process helping improve the quality of the produced learning material.

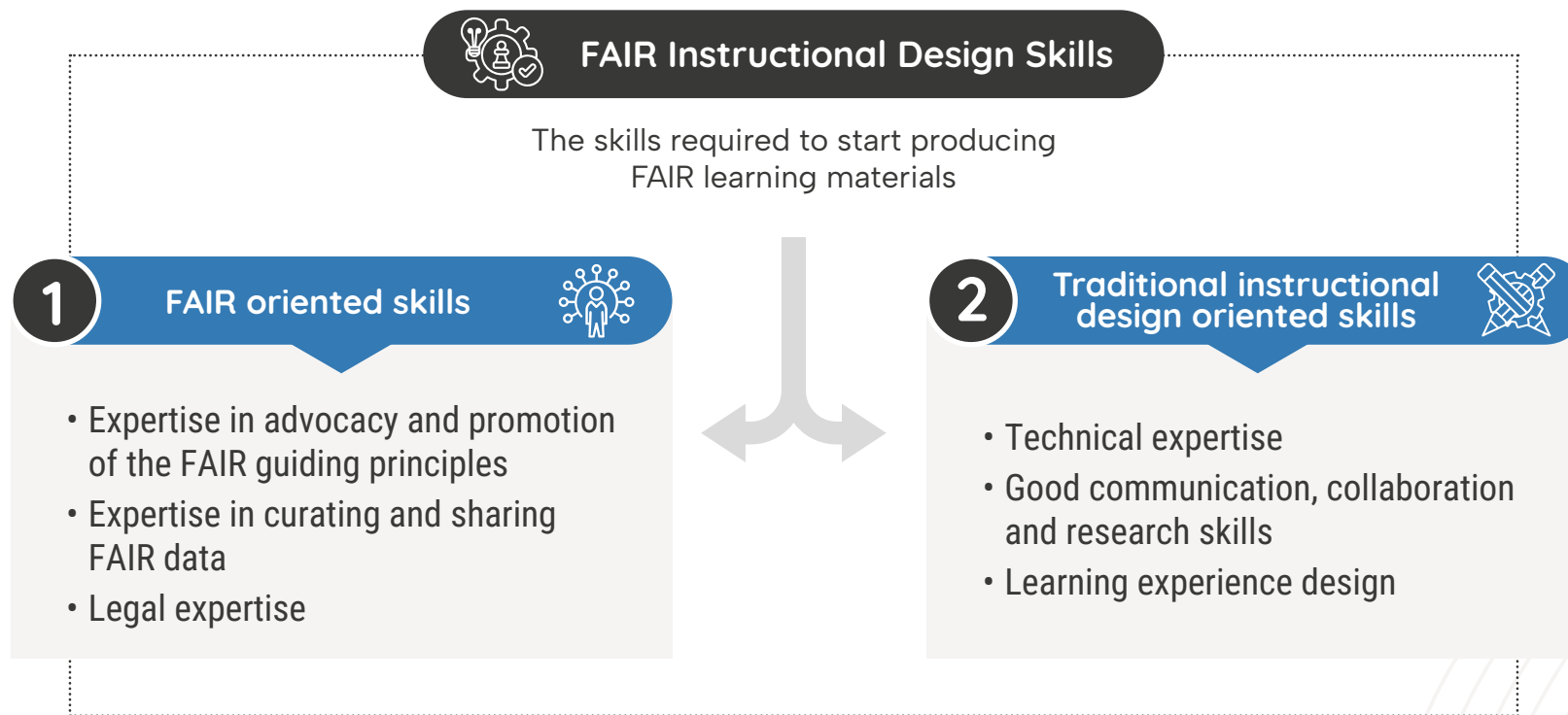




STAGE 1: PREPARE

FAIR Instructional Design Skills

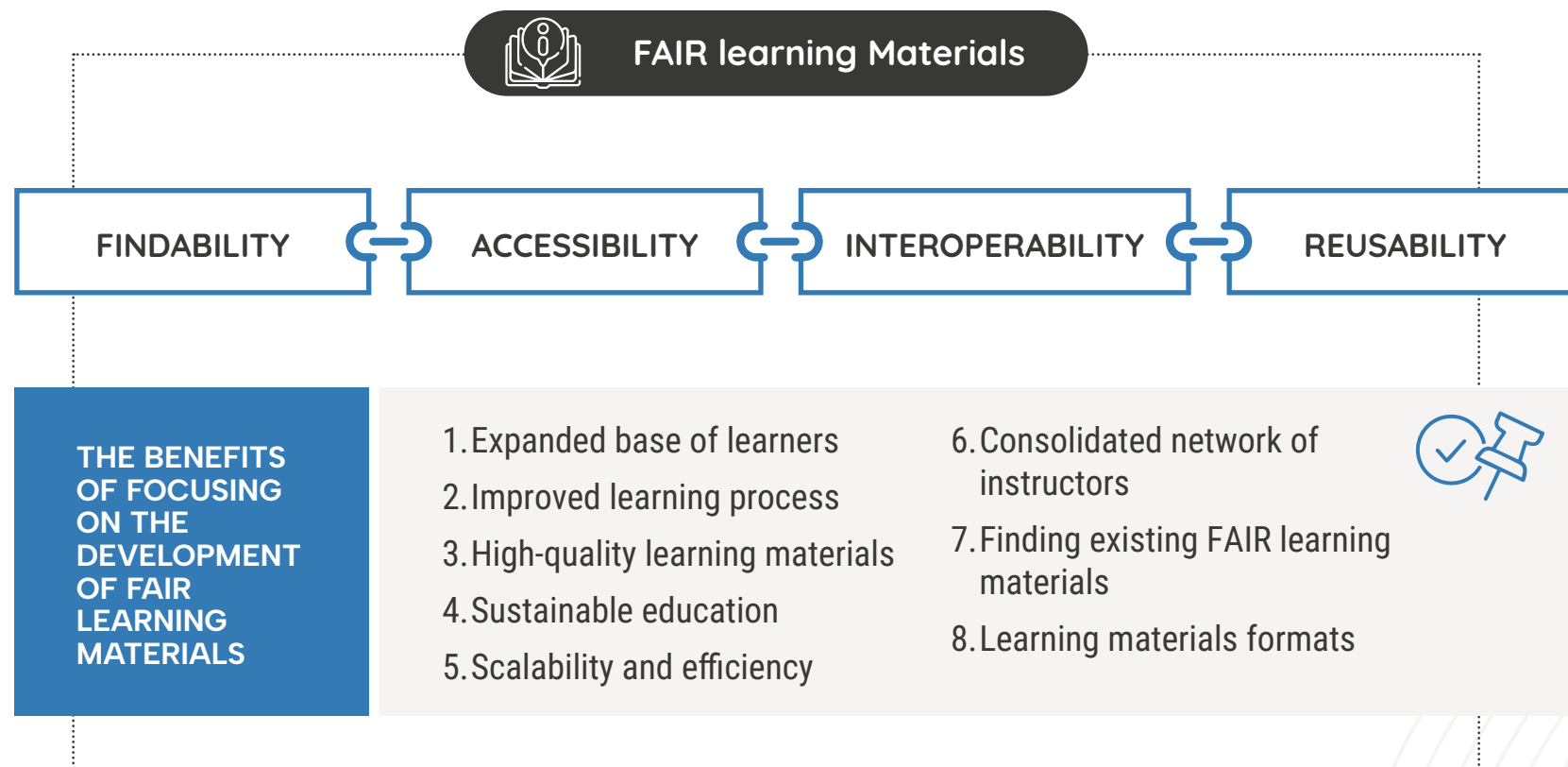
What are the specific skills that need to be obtained in order to successfully proceed with the instructional design of FAIR learning materials?

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FAIR Learning Objects

The FAIR principles for learning materials should not be applied to raw elements or simple information objects, but to learning objects and/or their aggregates. We define a FAIR learning object as any FAIR digital resource that supports learning developed around a single learning objective.

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FAIR learning objects exhibit the following characteristics:

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.

To ensure a digital object is findable:

- the object should be accompanied with sufficiently detailed descriptive metadata;
- a unique and persistent identifier (PID) such as a digital object identifier (DOI) should be used to point to the digital object.

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.

For the digital object to be accessible:

- the metadata and the object content should be understandable to both humans and machines;
- the digital object should be stored in a trusted repository;
- clear authentication and authorization procedures should be defined and outlined;
- although the access to the digital object can be restricted, the access metadata should always be open.

INTEROPERABLE

With a well-chosen scope (content, tools and implementation resources), the learning object can be consumed on multiple platforms.

The digital object is considered interoperable if:

- the metadata follows a commonly accepted metadata schema combined with agreed-upon controlled vocabularies;
- formal, accessible, shared, and broadly applicable language(s) and format(s) are used for the digital object representation.

REUSABLE

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.

To be reusable a digital object should have:

- a clear usage license;
- accurate information on provenance.

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**Keep in mind:****1. The FAIR principles refer to three entities:**

- the digital object;
- the metadata (information that describes the digital object);
- the infrastructure that stores or indexes the digital object (e.g. repository and catalogue).

2. When applying the FAIR guiding principles to learning materials, there are several aspects that need to be considered.**PERSPECTIVE**

Are the learning materials FAIR from a learner perspective or from the trainer/instructor perspective, or both? Using the FAIR-by-Design methodology we aim to make the learning materials FAIR from both perspectives.

GRANULARITY

One of the main decisions that need to be made when ensuring FAIRness of learning materials is to define the level of granularity on which the FAIR principles will start to be applied for a given set of learning materials. In other words, the main question is what is the minimum sized package of digital learning materials that is to be subjected to the FAIR principles? To ensure flexibility and minimise the overhead, the minimum viable package of learning materials on which one can apply the FAIR-by-Design methodology is based on the instructional design concept of learning object.

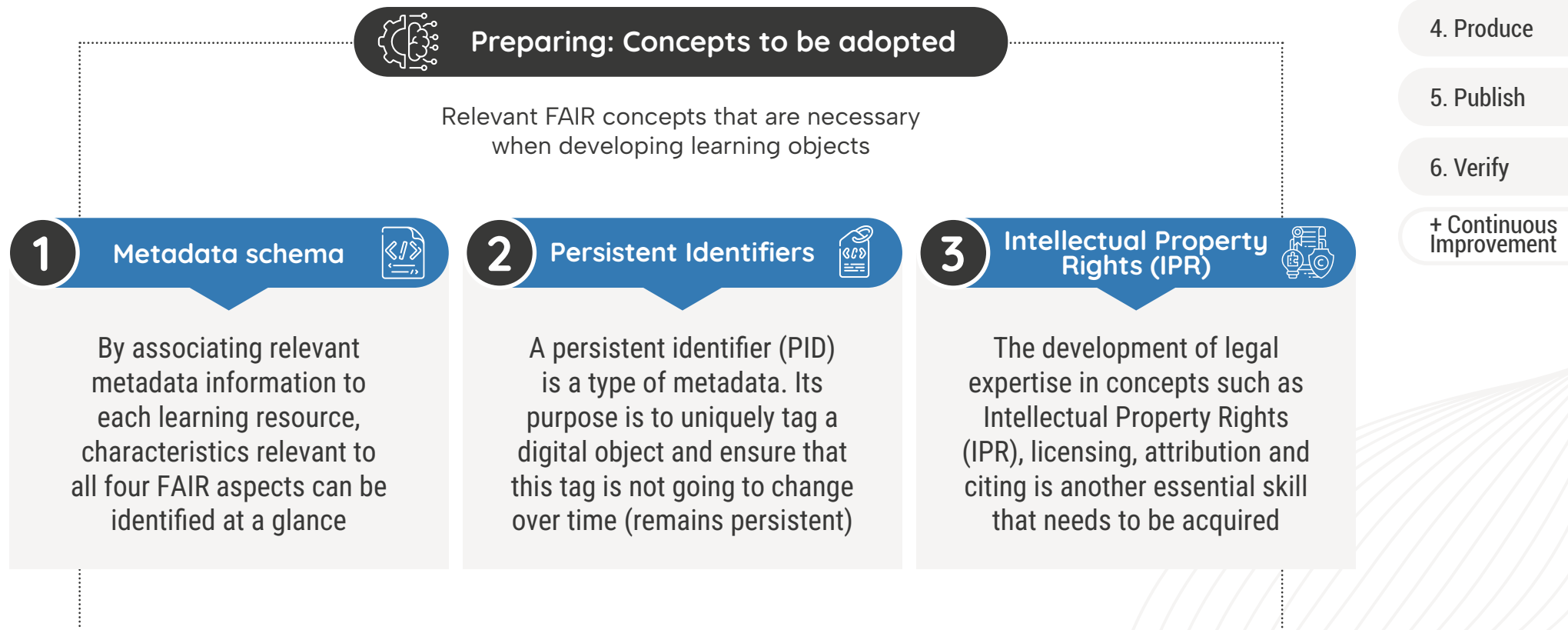
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Preparing & Ideating

PREPARING: CONCEPTS TO BE ADOPTED

The purpose of this section is to introduce all relevant FAIR concepts that are necessary when developing learning objects.

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1 Metadata schema

Metadata plays a central role in the implementation of the FAIR principles and enables easier sharing of data and material. By associating relevant metadata information to each learning resource, characteristics relevant to all four FAIR aspects can be identified at a glance. Agreeing on an existing, well-defined, and descriptive metadata set is essential for reusability of materials, and their findability through general purpose search engines and specialized catalogue.

RECOMMENDED RDA METADATA SCHEMA

DESCRIPTIVE INFO FIELDS:

1. **Title** = The human readable name of the resource
2. **Abstract / Description** = A brief synopsis about or description of the learning resource
3. **Author(s)** = Name of entity(ies) authoring the resource
4. **Primary Language** = Language in which the resource was originally published or made available
5. **Keyword(s)** = Keywords or tags used to describe the resource
6. **Version Date** = Version date for the most recently published or broadcasted resource

ACCESS INFO FIELDS:

1. **URL to Resource** = 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
2. **Resource URL Type** = Designation of the identifier scheme used for the resource URL, e.g., DOI, ARK, Handle
3. **License** = A license document that applies to this content, typically indicated by URL
4. **Access Cost** = Choice stating whether or not there is a fee for use of the resource (yes, no, maybe)

EDUCATIONAL INFO FIELDS:

1. **Target Group (Audience)** = Principal users(s) for which the resource was designed
2. **Learning Resource Type** = The predominant type or kind that characterizes the learning resource
3. **Learning Outcome** = Descriptions of what knowledge, skills or abilities a learner should acquire on completion of the resource
4. **Expertise (Skill) Level** = Target skill level in the topic being taught; example values include beginner, intermediate, advanced

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2 Persistent Identifiers

A persistent identifier (PID) is a type of metadata. Its purpose is to uniquely tag a digital object and ensure that this tag is not going to change over time (remains persistent).

The specific type of persistent ID to be used is very much related to the choice of where the learning materials are going to be stored and offered for access to learners and instructors. There are multiple choices available including general data repositories, learning objects repositories and/or learning management systems and platforms. Also, it is preferable that the chosen location for storing the learning materials is harvested (manually or automatically) by a relevant training catalogue.

3 Intellectual Property Rights (IPR)

The development of legal expertise in concepts such as Intellectual Property Rights (IPR), licensing, attribution and citing is another essential skill that needs to be acquired. The importance of understanding and applying these concepts is twofold: they play a major role in the process of selecting existing learning materials that can be reused during the creation of new learning materials, but also they are needed so that the newly created learning material can be offered for reuse to others.

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Some of the most important aspects that need to be clear at the beginning include:

COPYRIGHT

Original work can be protected by copyright law that grants the owner exclusive right to control certain rights such as reproduction. The copyright is owned jointly by all authors, or it may be owned by the employing institution. How copyright defines exclusive rights and free uses:

1. Any work that you create by default makes you or your institution/employer the copyright holder of it. Use of copyright protected work requires permission from the owner. Permission may not be required in the case of works licensed in the public domain and uses covered by Copyright Exceptions.

LICENSING

A license allows you to define rights and obligations regarding the use of your work.

How to use licensing as a tool to enable reuse:

1. One of the best sources of information for licensing reusable learning materials is Creative Commons. Their **Licence Chooser tool** helps authors share their work in a standardised way providing copyright licences that enable sharing and reuse of the creative work under the chosen conditions. The available CC Licence options can be found at <https://creativecommons.org/about/cclicenses/>. It is recommended that the least restrictive CC BY licence, requiring only that credit is given to the creator when reusing, is used when creating new learning materials.
2. It is essential to understand that when reusing existing learning materials, one must ensure that the licences of the included and adapted materials are compatible with each other. For these purposes, **the CC licence compatibility chart** can be used.

ATTRIBUTION AND CITING

How to use attribution and citing:

1. Acknowledgement of the reused materials through attribution is always strongly recommended (even if it is not a requirement of the licence). On the other hand, one condition that is required for all CC licences is attribution. The ideal attribution should include the title, author, source and license (TASL). For more detailed instructions Creative Commons offer a wiki page with the **Recommended practices for attribution**.
2. Citing can be used for including and referencing restricted works with limited copyright. However, in the case of using direct quotations with citing, it is essential that the amount of information referenced is very limited.

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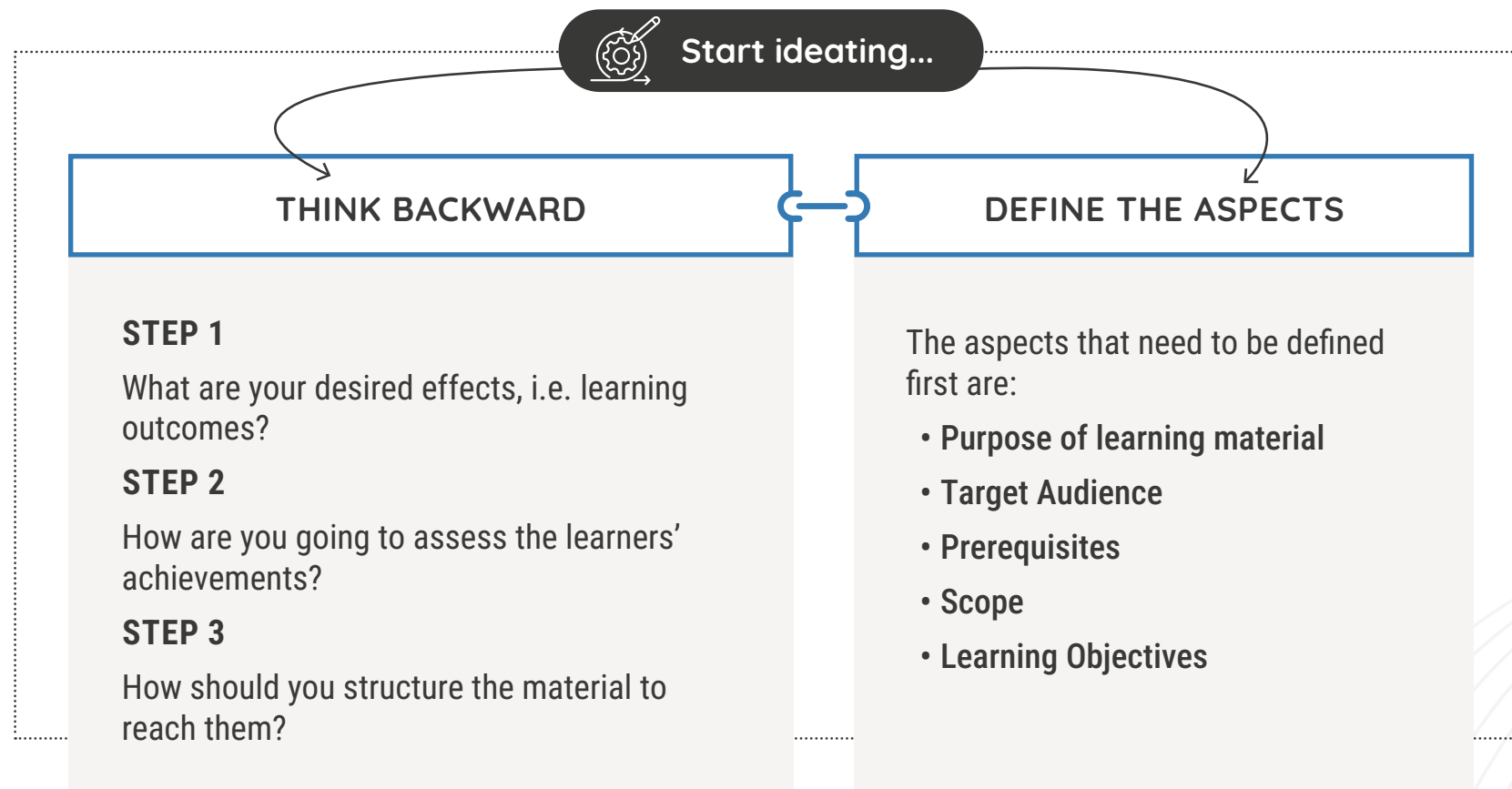
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Start Ideating...

Once these concepts are adopted, the instructional designer is then ready to start with the backwards instructional process. The aspects that need to be defined first are:

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The aspects that need to be defined first are:

1. Purpose of learning material

What is the purpose of the learning materials? This includes when and how the learning materials can be used and for what purposes they were initially developed, also known as primary use.

2. Target Audience

Who is the target audience? – is there a primary audience and is there anything specific that needs to be taken into account, such as localisation to cultural context or native language.

3. Prerequisites

Are there any prerequisites? What does the audience need to know or understand before starting the learning process?

4. Scope

What is the overall scope of the learning materials? – is it going to be a single learning object, or an aggregation of some sort such as a course, or maybe a learning path.

5. Learning Objectives

What are the learning objectives? What competences will be gained after successful completing of the learning process?

- ➔ To ensure standardization and wide understanding of the defined learning objective, it is best practice to define the learning objectives using a well-known taxonomy such as the **Bloom's taxonomy**. This approach will significantly improve the findability of the produced resources, as well as the potential reuse of individual learning objects in different aggregations.
- ➔ Note that to ensure the highest degree of reusability, each reusable learning object should have one well-defined learning objective. Multiple learning objectives should ideally be broken down into multiple learning objects.

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STAGE 2: DISCOVER

Once the preparation phase has been completed, but before the design and development of new learning objects is undertaken, it is a recommended best practice to discover existing related learning materials. Depending on the subject area, vast amounts of learning resources might already exist. Such reusability is at the core of the FAIR principles, promoting the extension and improvement of existing work.

During the discovery process, it is expected that not all found material will be open and freely accessible. Should such non-open resources need to be incorporated into the design of the new learning objects, care must be taken to ensure that the material is at least FAIR, before making the final decision. In this context, it is very important that clear accessibility information should be provided by the resource, outlining its access rules and criteria.

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Learning materials repositories

Unfortunately, at this stage there is no straightforward way to find readily available and reusable learning materials related to the topics of Open Science and EOSC. This is not due to the lack of such resources, as there has been a great number of projects and activities that offer training. However, there is no one catalogue of learning resources for instructors that has been accepted in the community as the place to go to when searching for existing learning resources.

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OER REPOSITORIES

There are many OER repositories available, however their potential for reusing learning materials for the purposes of designing Open Science related courses is still very limited due to a number of reasons:

- most of the OER repositories are hosted by USA institutions;
- most of the OER repositories store learning resources that are not related to Open Science;
- there is no one search engine that searches through all available OER repositories.



This is a short list of some of the most popular OER repositories and catalogues:

DOAB (Directory of Open Access Books) - provides access to high quality, open access, peer-reviewed books.

MERLOT (Multimedia Educational Resources for Learning and Online Teaching) - designed primarily for faculty, staff and students of higher education to share their learning materials and pedagogy. It provides access to curated online learning and support materials and content creation tools, led by an international community of educators, learners and researchers.

OASIS (Openly Available Sources Integrated Search) - a search tool that aims to make the discovery of open content easier.

OER Commons - a public digital library of open educational resources. Explore, create, and collaborate with educators around the world to improve curriculum.

OERTX - a public digital library of open educational resources for higher education. Search collections or create and collaborate to improve instruction.

Community of Online Research Assignments (CORA) - website with many assignments on many different topics including necessary materials to do each assignment.

GALILEO Open Learning Materials - aims to reduce the cost of textbooks to students and contribute to their retention, progression, and graduation.

FORRT (Framework for Open and Reproducible Research Training) - provides a pedagogical infrastructure & didactic resources designed to recognize and support the teaching and mentoring of open and reproducible science, offering FAIR teaching and mentoring resources

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EOSC PROJECTS RELATED TRAINING MATERIALS AND CATALOGUES

Many EOSC projects have created their own learning platforms or even more general repositories with integrated catalogues:

| | |
|---|--|
| EOSC Training Catalogue (currently under development) | <u>EOSC-Nordic Training Library</u> |
| <u>EOSC Synergy learning platform</u> | <u>OpenAIRE Open Plato</u> |
| <u>EOSC Pillar RDM Training and Support catalogue</u> | <u>Elixir Training Platform</u> |
| <u>NI4OS-Europe Training Platform</u> | <u>Europeana - Discover Europe's digital cultural heritage</u> |

GENERAL REPOSITORIES AND PLATFORMS

Lately they have become an increasingly favorite location for hosting instructor facing learning materials.

- Searching within should be done with greater care as the filtering options are general and it is difficult to search for a specific learning resource type.

A short illustrative list is:

Creative Commons Search - engine that helps find content that you can share, use and remix as it is provided under a CC license

Zenodo - a multi-disciplinary open repository maintained by CERN

OSF - a free, open platform to support your research and enable collaboration

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Keep in Mind

POTENTIAL FOR REUSE

As licenses determine the possibility of reuse, upon discovery of existing learning resources license identification must be carried out to ensure that the resource can be reused with attribution under the specified rules.

- Materials with non-permissible licenses can be used for inspiration only.
- Materials with permissible licenses should be reused based on the license rules.

OPEN MULTIMEDIA

If you are planning to reuse multimedia in your learning materials (especially if using presentations) then the University Library Groningen offers an **extensive list of open multimedia websites and services** that should help you find multimedia with permissible licenses for reuse.

Another option is to use the images search in the Google engine together with the Tools -> Usage Rights -> Creative Commons Licenses.

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STAGE 3: DESIGN

Once the discovery stage is completed, you enter the third step of the backward instructional process. In this step the instructional designer needs to define the content concept map of the learning materials defining the sections, modules, units and learning objects it is going to contain. When the learning materials syllabus is completed, the design continues by creating a blueprint of the complete structure of the learning materials, including additional documents that serve as an instructor facilitator kit promoting reuse by enabling others fully understand the learning content and its delivery.

Conceptualisation

CONTENT CONCEPT MAP

Concept mapping is a tool for visualising interrelationships between concepts in an integrated, hierarchical manner. Using concept maps helps clarify the relationships among learning concepts when designing or redesigning your learning materials. The main goal of the concept map is to start outlining the specific components of your training, organize the components and make sure that they fit in with the defined learning objectives.

It does not matter which type of concept map you will use (hierarchical, spider, flowchart, etc.), the main focus here is to flesh out the components that you would like to include in your materials.

One of the most important steps in this stage when it comes to development of Open Science related learning materials is to align the syllabus with the developed Minimum Viable Skills profiles. These profiles define the skills and competences necessary for a set of identified profiles related to Open Science. Thus, the **MVS profiles catalogue** should be used as a starting place for the development of the concept map.

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SYLLABUS

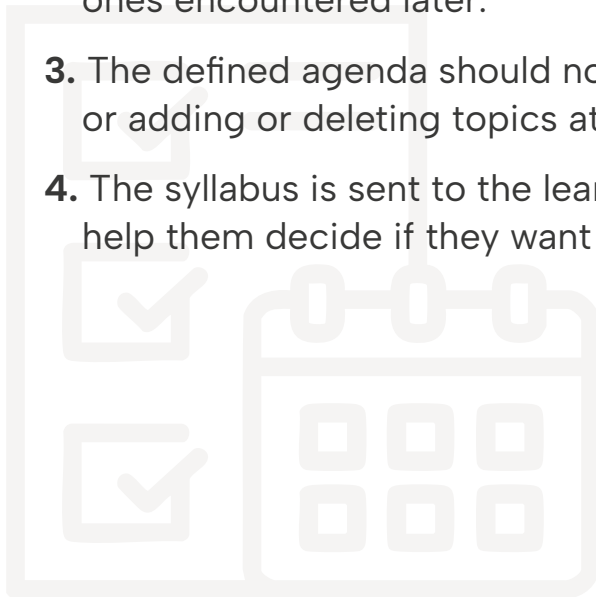
Once you have identified your learning concepts, the next step is to sequence them into an instructional sequence (agenda). This instructional sequence will become your blueprint for the organisation of the learning materials and the definition of the syllabus.

In essence the blueprint takes the input from the creative concept map and organizes it into a more formal outline.

Formally, we call this learning materials outline syllabus.

Remember that:

1. The syllabus can present a higher level sequence outline, that can be later broken down into smaller subtopics if necessary.
2. The topics sequence should be defined so that the concepts introduced early help with the ones encountered later.
3. The defined agenda should not be very rigid thus preventing changing the sequence of topics or adding or deleting topics at a later stage.
4. The syllabus is sent to the learners and should provide them with all necessary information to help them decide if they want to follow the training related to the learning materials.

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Hierarchical structure

A hierarchical organisation of the learning structure helps create granular learning resources that can be easily reused, but also enables easier implementation of the CC remix licensing rules and the definition of adapter license.

LEARNING STRUCTURE

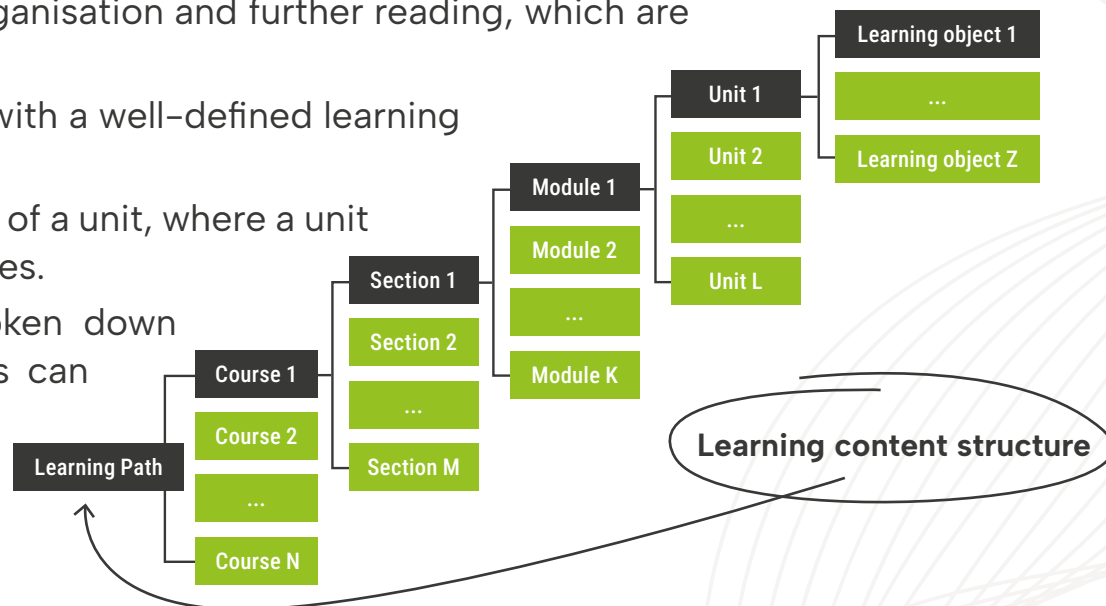
Once the higher level outline is defined in the syllabus it is time to flesh out the rest while applying the same approach and concepts only on lower aggregation levels. You want to end up with a hierarchical structure that will define the lowest level elements (learning objects) of your learning materials.

The overall structure of an aggregated learning content, i.e. course or training, should include:

- Sections – each referring to one overarching theme, which are comprised of
- Modules – each with defined main goals, description and rationale, which are comprised of
- Learning units – each corresponding to one lesson with its specific objectives, activities and tasks, description of organisation and further reading, which are comprised of
- One or more learning objects – each with a well-defined learning objective.

It is recommended to go down to the level of a unit, where a unit will have no more than 4 learning objectives.

Flexibility is key! Learning materials broken down into flexible self-contained learning units can be reused more easily by fitting them and adapting them in other learning structures.

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Licensing and Attribution

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COMBINING AND REMIXING CC LICENSES

When reusing learning materials there is sometimes need to combine learning materials from different sources available under different licenses.

You may combine any CC-licensed content so long as you provide attribution and comply with the NonCommercial restriction if it applies.

If you want to combine material in a way that results in the creation of an adaptation (i.e. a “remix”), then you must pay attention to the particular license that applies to the content you want to combine. For these purposes, **the CC license compatibility chart** can be used.

ADAPTER’S LICENSE

If you make adaptations of material under a CC license (i.e. “remix”), the original CC license always applies to the material you are adapting even once adapted. The license you may choose for your own contribution (called your “adapter’s license”) depends on which license applies to the original material.

This chart details the CC license(s) you may use as your adapter’s license.

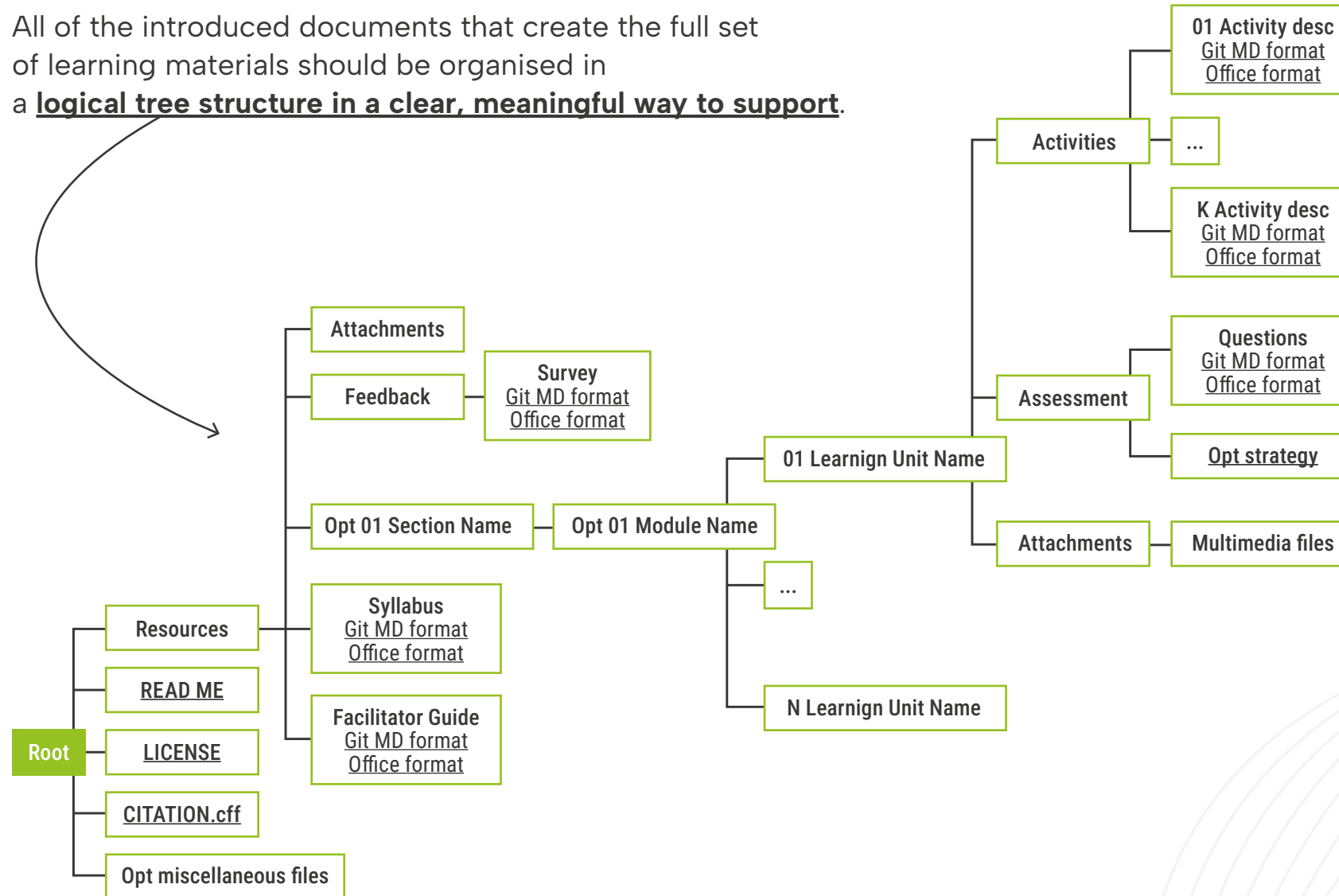
ATTRIBUTION

Do not forget that all reused material (with or without adaptation) needs to be attributed to the original author according to the TASL rules (or in another format if specified by the author).



Logical organisation

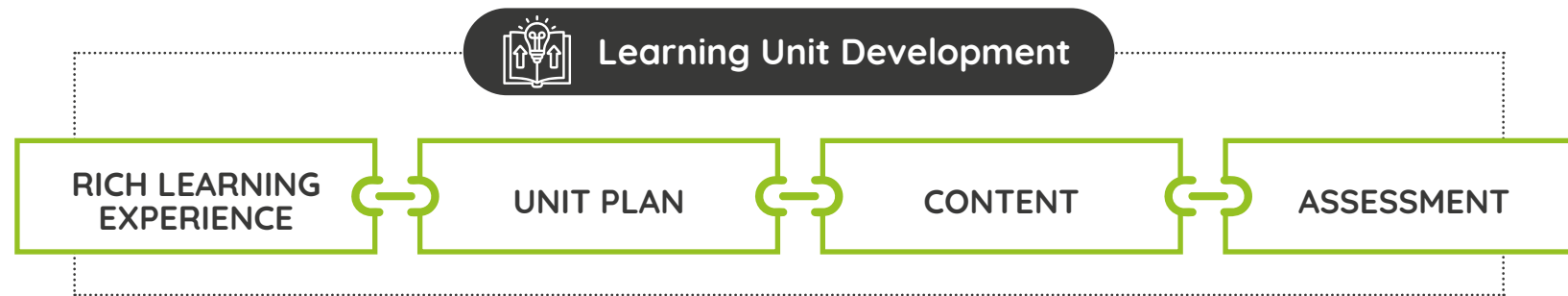
All of the introduced documents that create the full set of learning materials should be organised in a **logical tree structure in a clear, meaningful way to support**.

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Learning Unit Development

Once the structure is defined and the reused content is identified and attributed, it is time to move on to the design of the new learning content and all of its accompanying resources.



RICH LEARNING EXPERIENCE

Effective learning experience is crucial for application of the obtained knowledge and skills in real world context. To achieve this, not only the learning objectives, but all content, activities, assignments and assessments must be learner-centered.

Learners perform best when they are engaged in authentic activities, collaborate with peers to share and deepen their understanding, and apply their existing skills to different contexts and new problems.

Rich learning experiences can be supported by:

- inquiry-based learning structures, such as projects and performance tasks
- thoughtfully interwoven direct instruction
- opportunities to practice and apply learning

Units should be well structured so as to reduce the unnecessary cognitive load, and based on multiple modalities and tools for accessing information and expressing learning to support different types of learners.

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LEARNING UNIT PLAN

To ensure rich learning experience it is imperative to develop a learning unit plan. This document incorporates all aspects that should lead to a high quality learning experience as it defines the plan on how to use teaching methods and the learning content together with activities to achieve the defined learning objectives.

It is recommended that you follow the Hunter's model for developing a learning unit:

1. Set the learning objectives

- These are lower level learning objectives for the particular learning unit.

2. Identify the needs of the target audience

- Present the idea on how the target audience should achieve the objectives

3. Create a plan of your training material

- Present the outline of the unit

4. Present the Hook

- Show learners why the content is important

5. Instruct the lesson

- Transfer your knowledge to the learners

6. Provide time to practice

- Let the learners apply to knowledge

7. Wrap-up

- Do an overview of what has been discussed and what has been learned

8. Evaluate

- Determine whether the learning objectives have been met

9. Reflection

- Did everything go as planned or something needs to be improved?

Don't forget!

When developing the plan you will need to think about the teaching methods that will be used during the training.

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LEARNING CONTENT

Once you have a plan, it is time to start developing the learning content. Remember to design the content so that it appeals learners with different modalities (verbal, audio, read/write, kinesthetic) including different multimedia.

The learner's notebook is the main learning content that you are aiming to introduce the learners to. The content of each learning unit notebook should include:

- | | | |
|--|---|--|
| <ul style="list-style-type: none">• Brief introduction• Learning objectives• Target audience | <ul style="list-style-type: none">• Duration• Prerequisites• Learning tools | <ul style="list-style-type: none">• Main content• Summary• Suggested reading |
|--|---|--|

ASSESSMENT

Thinking about how you can assess the learners obtained knowledge is part of step 2 of the backward instructional design process. There are many different types of assessments that can be performed. Although they can be setup as formative (after each learning unit) or summative (one assessment at the end), from the FAIR-by-Design perspective, it is recommended that at least the questions that form the assessment are setup in a formative way. In this way each learning unit comes with an assessment related to that particular learning unit and can be reused independently.

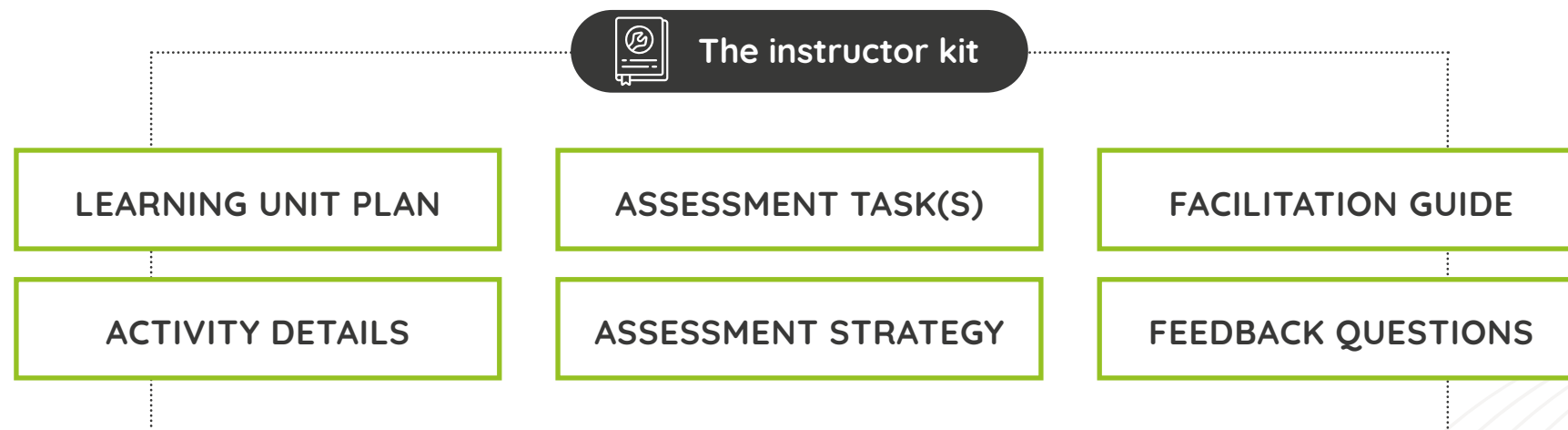
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Instructional design and facilitation

To be effectively reused, the learning materials should also be augmented with accompanying materials that comprise the so-called instructor kit. The kit is especially important for traditional learning settings (face to face), but also for hybrid and blended delivery of the learning material. Even in the case of online learning, there usually is an option for some type of interaction with the instructors, and the way this interaction is organised, its timing and frequency, scope and methods should be explained in the accompanying material.

The instructor kit should help facilitate the process of other instructors reusing the learning material. Thus, a comprehensive instructor kit should contain the following information:



Most of the items were already introduced and discussed, here we will only focus on the last documents: the **facilitation guide** and the **feedback questions**.

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FACILITATION GUIDE

As the syllabus represents the learner's view of the learning materials, the facilitation guide is a document that represents the trainers view and aims to enable a smooth and efficient training. A well-defined facilitation guide should include the following elements:

1. what to do

- a. before
- b. during
- c. after the training

2. where are all of the materials that should be used during the training

3. how to prepare the materials beforehand

4. how to prepare the learning environment

In the case of a summative or common assessment strategy it can contain this information as well. For best visibility, the guide should also contain shortcuts to all activities planned. However, any specific details and notes should be available in the learning unit plan.

FEEDBACK QUESTIONS

At the end of the learning process you should gather feedback from the learners so that they can provide comments on what worked well and what should be improved in the training and learning materials. The aspects you should focus into while developing the feedback questions are:

1. Overall training rating

2. Specific training aspects rating

3. Acquired knowledge rating

4. Insights

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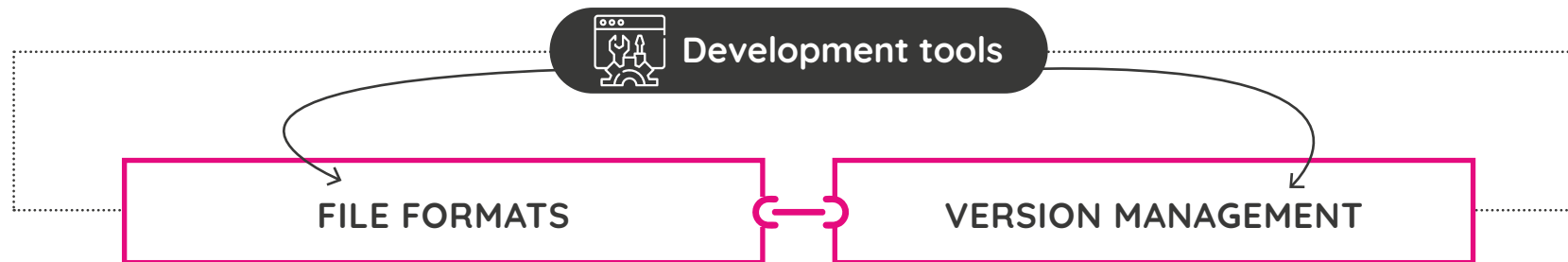


STAGE 4: PRODUCE

The next step after creating the syllabus and defining the overall structure of the course is to develop the new learning objects themselves. Throughout this activity, there are three important aspects which need to be taken into consideration:

- The intermediary and final file formats of the produced learning objects;
- The required software tools for producing and consuming the learning objects;
- Ensuring future-proof compatibility and longevity of the learning objects.

Development tools



FILE FORMATS

An intermediate file format is a file format used during the production phase of the learning objects, and is aimed at direct contributors to the content itself. A final file format is obtained by transforming the intermediary file format, making it ready for consumption by a wider audience, focusing on its visual representation, interactivity, and ease-of-use.

The FAIR-by-Design methodology by no means restricts the use of intermediary or final file formats. The file formats are your choice, the only recommendation is to use open file formats so that they are easily reusable by others.

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Don't forget!

Both the intermediary and final formats need to be chosen with care, since a restrictive or proprietary choice might limit the number of people who can contribute to the content during its development or make the final output inaccessible due to the lack of supported software client applications. To better visualize the available options, **this figure** presents a taxonomy of file formats along with potential tools which can be used either for development or consumption.

VERSION MANAGEMENT

It is very important to use a version management system to keep track of all changes made in your learning materials. This is even more pronounced when a team of instructional designers is working on a common set of learning materials. The version management system will ensure that all changes are synchronised across the team members and will provide a way to resolve any conflicting changes. The system also provides a way to keep the history of changes and revert back to an older stable version if necessary.



USEFUL INFO

Git is one of the most popular version management systems that easily enables remote collaboration



Content Mix

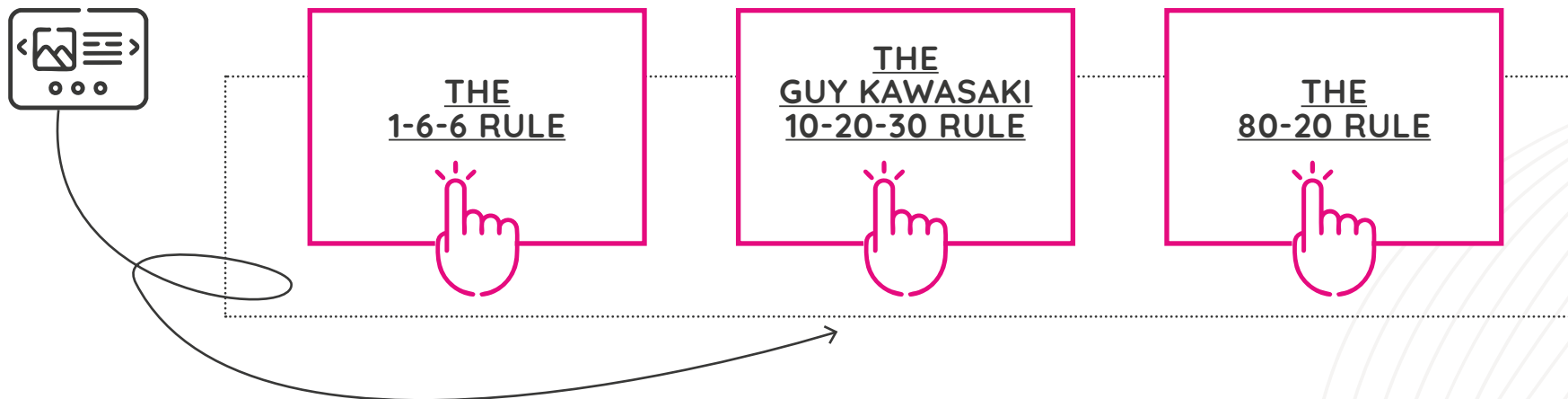
Before reusing existing content, careful attention needs to be paid to its original license, and whether it is compatible with the assigned license of the newly developed materials.

Note that since the discovered content can be in any file format, additional effort might be required to convert it to the chosen file formats.

THE SLIDE DECK

For instructor led learning environment a slide deck is used as an additional supporting learning material that helps support the training process and provides visual cues for the learners. The slide deck should be prepared in an open format (such as pptx) so that it is reusable by other trainers. It is best if it is shared with the learners in a PDF format to ensure correct layout when opened with a variety of tools on different platforms.

While creating a slide deck **don't forget to implement best practices on slide layout** such as:

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Accessibility

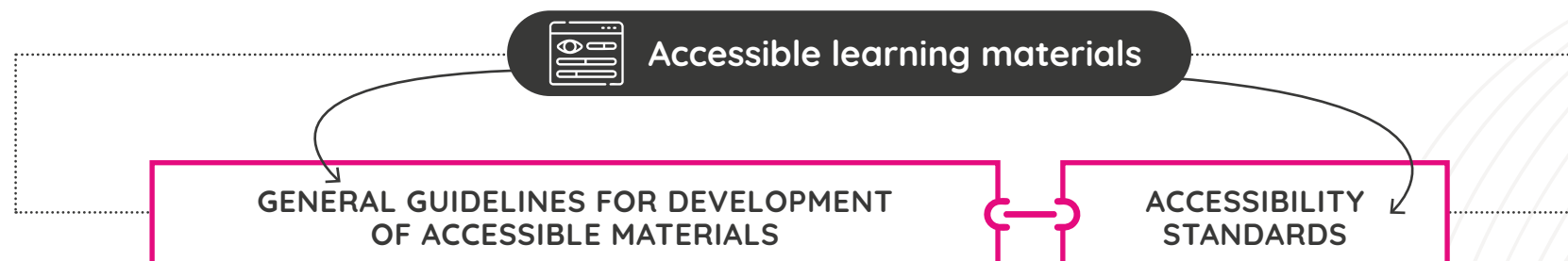
All developed learning content should be accessible to a wide range of learners with different needs from a variety of backgrounds, abilities and learning styles. To ensure this the developed content needs to be checked so that access is optimised and all unnecessary barriers are removed making it inclusive and easier to engage with by all learners including people with disabilities.

ACCESSIBLE LEARNING MATERIALS

Accessible educational materials (AEM) are defined as educational materials that are designed or later enhanced in such a way that it makes them usable across the widest range of learner variability.

These are just a few examples that illustrate the need for accessible materials:

- simple text structure helps learners with a variety of learning needs, including learners for whom the language used is not their native language
- simple navigation through the materials should help access the content from mobile devices, as well as learners with low vision
- adding captions to videos helps learners with hearing impairment as well as learners that have low prior knowledge on the subject and key terminology.

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GENERAL GUIDELINES FOR DEVELOPMENT OF ACCESSIBLE MATERIALS

Most of the techniques used for development of accessible learning materials are based on the Universal Design for Learning (UDL) that focuses on the design of learning materials that are aimed to be inclusive of as many learners as possible. This approach, combined with the assistive and accessible technologies, can ensure that every learner has access to the same materials.

UDL is based on three fundamental principles:

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Multiple means of representation

↪ learning content should be presented in different ways and formats

Multiple means of action and expression

↪ several options for action and expression should support the demonstration of acquired knowledge

Multiple means of engagement

↪ learners differ in what engages and motivates them so multiple options should be provided.



Content Finalisation

The final touches when it comes to learning content definition are to be done once all learning units are fully completed. These last steps include:

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Review of the syllabus and adding machine-readable metadata

➞ The content of the syllabus was defined during the Design stage. Remember that the syllabus contains all fields defined with the RDA minimal metadata schema thus providing all required information in a human-readable format. Aim to also provide the same information in a machine-readable format.

Provide a license file

➞ Ensure that you provide a license file that defines the overall license of your learning materials. This license must be compatible with the reused material and the remixing and adaptation rules.

➞ Define the facilitation guide to other instructors: what to do before, during and after the training based on the learning materials.

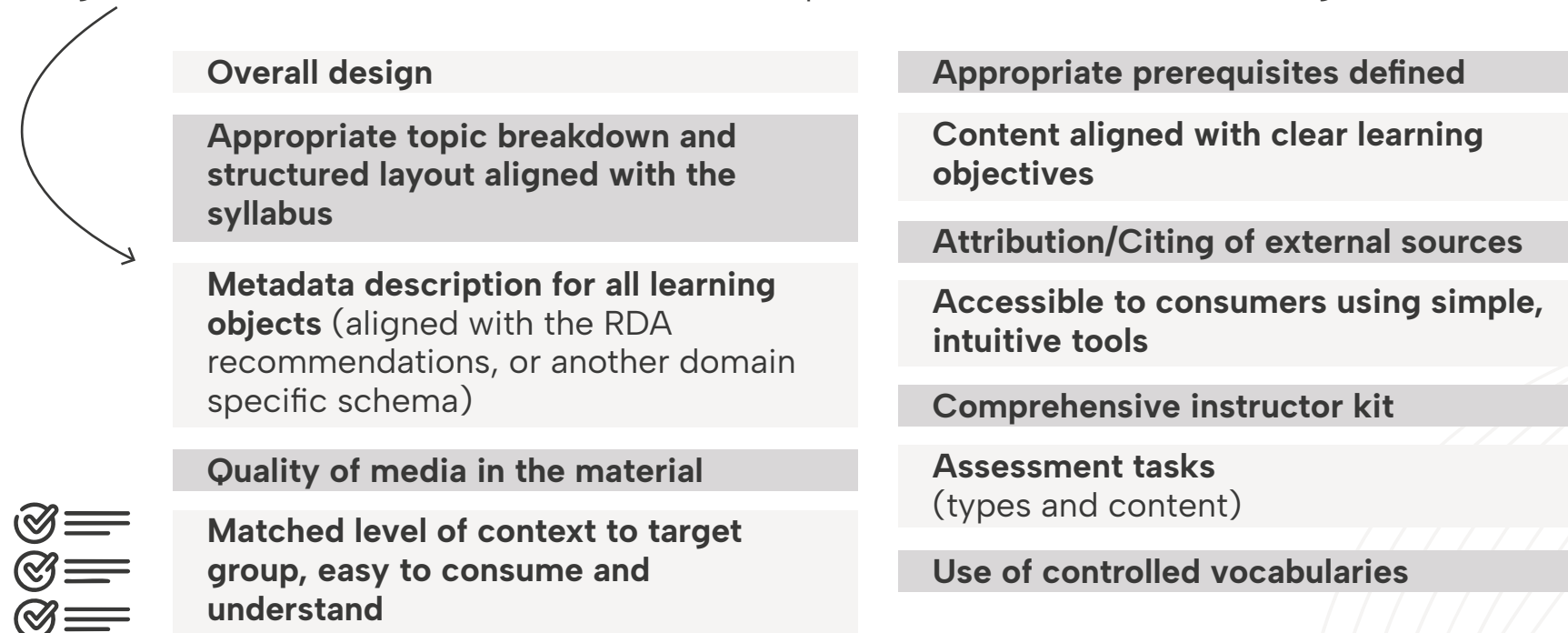


Internal Quality Assurance

Performing an internal quality assurance (QA) help ensure that all required documents are present, and that the structure, layout and content are valid.

The internal QA can be performed by the same people that have done the development. If the work has been done collaboratively, it is preferred that the checks are done in such a way that the person that checks the learning unit is not the same person that developed the learning unit. This approach will improve the chance of catching some small bugs and errors. The overall check of structure and presence of all required elements should be done by the main collaborator. The checks of authorship, citation and similar should be done by all collaborators.

A high-level internal QA checklist that covers all aspects should include the following:

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STAGE 5: PUBLISH

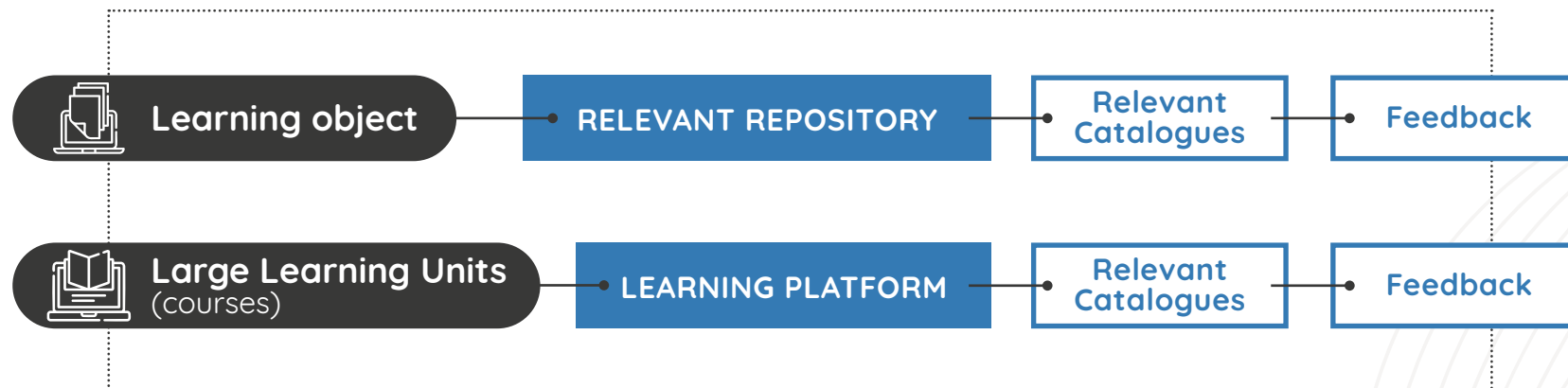
The publishing phase of the workflow refers to the release of the produced learning objects and associated metadata. This activity applies to both newly created learning objects and new versions of previously published objects.

Having FAIR learning materials does not always mean that the materials are open to everyone and there are no costs or access rules attached. When restrictions apply, the bundle that is going to be published in an open repository (such as Zenodo) should contain the following:

Syllabus, that contains all metadata that describe the materials.
Metadata should always be open.

Accompanying files (optional), augment the description of the materials and describe the details when it comes to accessing and using the materials from a trainer perspective.

Another alternative is to publish the materials in a closed repository where the corresponding access rules can be implemented.

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Preparing the reusable bundle for other instructional designers

Additional important files that need to be updated before publishing the materials include:

CITATION.CFF

Citation files are plain text files with human- and machine-readable citation information that tells others how to cite or attribute your work.

README

Readme is a text file that introduces and explains the contents of your learning materials. Written in a plain text format it usually describes the context and defines how the materials may be reused or co-created.

LICENSE

Plaintext file that defines the license of your learning materials. Just copy paste it from the official CC website. Reminder: CC-BY-4.0 is the recommended license.

CODE_OF_CONDUCT

A code of conduct defines the rules for how to engage in a co-creation community. It is based on the premise of an inclusive environment that respects all contributions.

RELEASE_NOTES

A release note is a report published alongside new or updated version of your learning materials that details the changes in the new version.

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These files should be bundled together with the learning materials editable source files (learning content plus full facilitation kit).

This bundle should be published on a collaborative platform where other instructional designers can easily access it in order to reuse or contribute to it. A unique PID should be used for the main version of the published bundle.

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One of the preferred platforms to host the editable (source) format of the learning objects for collaborative development can be GitHub. GitHub provides built-in versioning mechanism, enabling instructors to easily track the versions of the learning objects. However, while it does offer permanent storage, GitHub does not provide persistent identifiers for the hosted objects. To overcome this shortcoming, the integration between Zenodo and GitHub can be used.

PUBLISHING TO LEARNING PLATFORM FOR LEARNERS

Learning objects published as part of larger learning units, such as courses are usually published on learning/training platforms. They are mostly targeted toward the learners/trainees for individual consumption. Therefore, in this case, the final file formats should be used in combination with additional features dependent on the chosen learning platform.

LIST IN RELEVANT CATALOGUES

To make the learning materials more easily findable, after publishing in the relevant repository and learning platform, they should also be listed in relevant training catalogues. There are different catalogues available: thematic, national, regional, project-based etc.

FEEDBACK GATHERING

Once the materials are published and made available to the public, there should be mechanisms in place that will enable gathering feedback about their use. Collecting feedback on the published learning materials is key to implementing continual improvement. The exact type of feedback collection depends on the way the learning materials are presented to the users/learners.



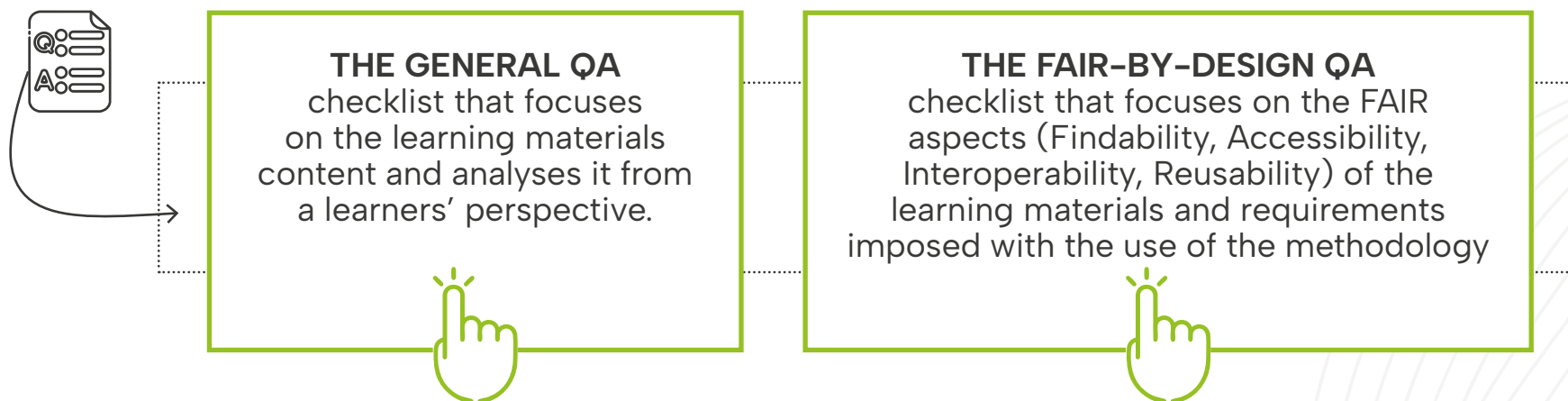
STAGE 6: VERIFY

Quality Assurance and FAIR verification

When publishing is completed, the learning materials are made available for both the learners' and instructors' communities. The publishing process consists of many steps taking place on several different platforms and is therefore prone to errors. It is thus prudent to verify that all is as it should be including the FAIR aspects of the learning materials. In addition, this is the moment when external quality assurance (QA) should be engaged to assess the produced learning materials from both the learners' and instructors' perspective.

SELF-CHECK QA

It is imperative that you first go through a self-check phase to ensure everything is as intended. In Skills4EOSC, **T2.4 have developed a number of QA checklists** that should be used for this process, two of which are the most important from the FAIR-by-Design methodology point of view.

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EXTERNAL QA

To truly view the produced learning materials through the lenses of learners and other instructors, you need to perform a QA check with the help of an external party. This external party should be someone who has not been involved in any step of the materials design, better yet has not seen the materials ever before. In this way, you will have a pair of fresh eyes that will review the learning materials without any cognitive bias.

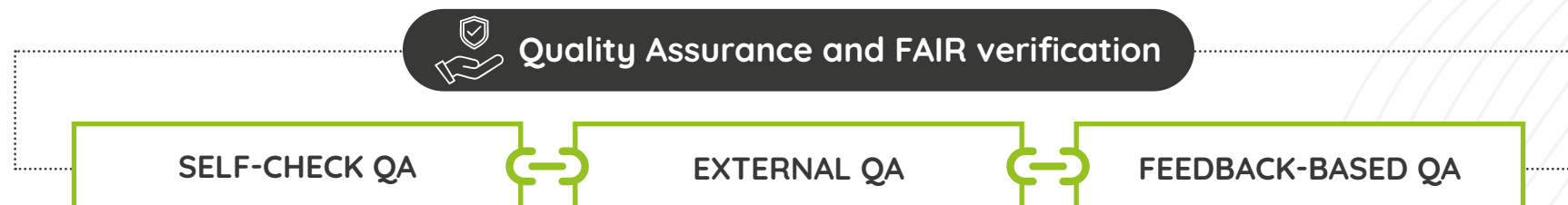
To further support this effort the chosen QA reviewer should be an expert that is very well versed in the requirements for engaging learning content and learning styles, as well as the FAIR principles. It is their job as an external QA reviewer to evaluate the learning materials performance, quality, and suggest improvements using an objective and independent perspective.

The external QA reviewer can use the T2.4 QA guidelines and checklists as a starting point for the QA, but should be encouraged to go more in-depth with the review process.

The high impact recommendations in the QA review report should be resolved as soon as possible. The lower-level improvement recommendations can be taken into account as relevant input for the continuous improvement step.

FEEDBACK-BASED QA

An integral part of the QA process is using the feedback form to evaluate the performance and identify areas of improvement for the developed learning materials. For these purposes the feedback gathered via the implemented feedback form should be regularly analysed and any comments and insights should be taken as input into the continuous improvement phase.

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+ CONTINUOUS IMPROVEMENT

Incremental improvements

Learning materials are never completely finished. There is always room for improvement, and they often need to be updated to keep up with developments and changes in the subject area.

Therefore, a regular analysis of all QA aspects is necessary to identify potential elements for improvement. Based on the outcomes of the feedback analysis, the authors of the learning materials should make a plan for the development of a new version of the learning materials.

FEEDBACK ANALYSIS

There are multiple sources that can serve for feedback gathering and QA:

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Feedback form

External QA recommendations

Self-reflection after training

Collaborative platform changes and suggestions

Gathered comments from external contributors

Direct mail contact

Any other means of communication

(e.g. feedback from workshops, discussions, team meetings, etc.)



The next step is to decide which of the improvements will be addressed in the next version and how will this be achieved. Note that depending on the number of identified improvements, you might need to go through the improvement cycle multiple times. It is recommended that the changes are done in an incremental fashion and that changes done in one version are logically related. This helps both designers and users to better understand the differences between the versions.

NEW ITERATION

The work on a new iteration starts once the list of identified improvements that will be incorporated into the new version is finalised.

The next step is to organise the work regarding the required changes to the learning materials. Depending on the identified improvements, the changes may bring you back to the Produce stage implementing changes in learning units, to Design if restructuring of the learning material is needed, or even to Prepare if you are changing any overarching learning objectives.

When all planned changes are implemented following the requirements and recommendations of the relevant stage(s), you can then move again through the Publish stage and create a new release with a new version number that is related to a separate entry in the Release Notes.

The recommendation based on best practices is to keep the versioning in the Major.Minor.Patch version number sequence.

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Increment the **patch** number in case of technical fixes only

Increment the **minor** number if the incremental improvement does not change the overall structure of the learning materials.

Increment the **major** number if the changes include change in the overall structure of the learning materials.

Don't forget to update the resources on the Learning Platform based on the new version of the source materials.



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 Funded by
the European Union

co-funded by
 UK Research
and Innovation

Skills4EOSC has received funding from the European Union's Horizon Europe research and innovation Programme under Grant Agreement No. 101058527 and from UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee [grant number 10040140].