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P4ELECS
Platform for
Electrification Skills
& Competences

Report: P4ELECS

D2.1
Quality Guidelines for BBs and Courses

ERASMUS-EDU-2023-PEX-COVE PROJECT ID 101144017

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Glossary

BB	Building Block Piece of educational material, consisting of elements (reader, PowerPoint presentation, video, exercises, self-assesment with answer keys, …) related to a particular question or topic.
BBP	Building Block Platform BBP is hosted by Xdemia
CDIO	Conceive, Design, Implement, Operate. Based on the CDIO initiative of MIT
EQF	European Qualification Framework
HEI	Higher Education Institutes
MC	Microcredential
SPIDER	CDIO map that contains BBs relevant to the topic of the spider
ULO	Unit of learning outcomes An ULO describes the knowledge, skills and attitudes a learner should acquire
VET	Vocational Education and Training
WP	Work Package

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Summary

This deliverable is developed in work package 2 (WP 2). The responsibility of WP 2 is to articulate educational guidelines to develop building blocks (BBs) in WP 3, 4 and 5 and P4ELECS courses in WP 7 and this in relation to the Building Block Platform (BBP) (WP 6) (see figure 1). The educational quality guidelines describe the shared principles and working approach that BB-developers or course-designers follow when developing learning materials and courses. The guidelines help to keep everything consistent throughout the project.

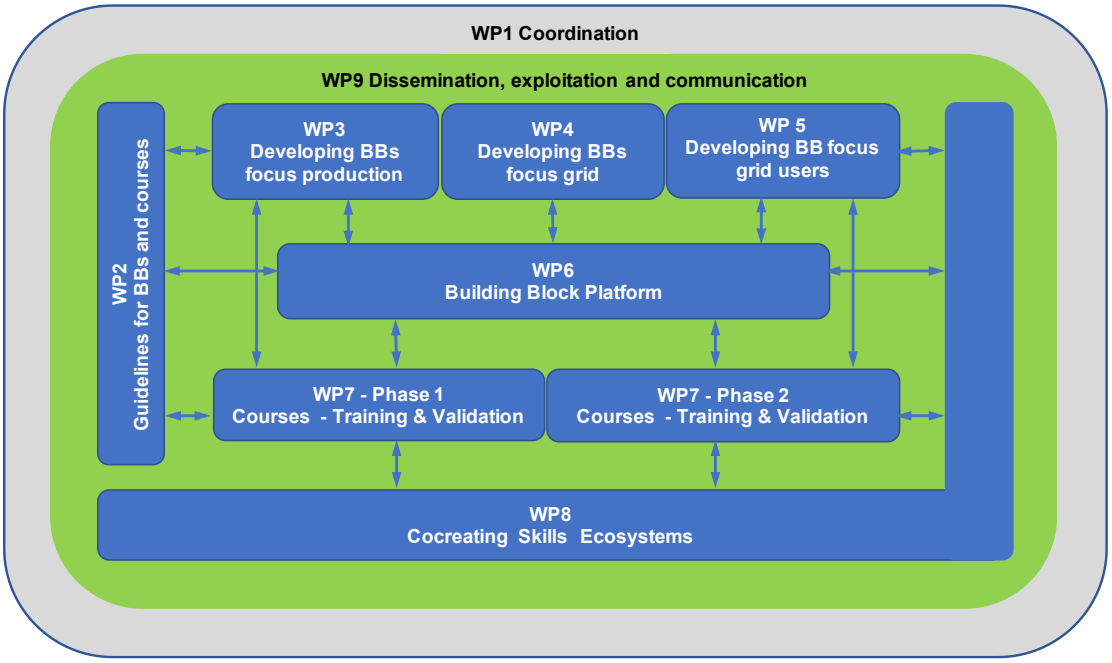
The deliverable outlines a full description of the four distinctive concepts of P4ELECS: Building Blocks, CDIO-spiders, courses and the building block platform. In addition it presents the educational quality criteria for building blocks and for courses. The provided guidance to comply with these criteria is described.
The educational quality criteria and the associated guidance contributed to the development of a shared understanding among partners and supported consistency in the educational materials developed within the project

Introduction

1.1 Objectives and activities of WP2

This deliverable is developed in work package 2 (WP 2). The responsibility of WP 2 is to articulate guidelines to develop building blocks (BBs) in WP 3, 4 and 5 and P4ELECS courses in WP 7 and this in relation to the Building Block Platform (BBP) (WP 6) (see Figure 1). The guidelines describe the shared principles and working approach that BB-developers or course-designers follow when developing learning materials and courses. The guidelines are also used to review the quality of the developed material. The guidelines help to keep everything consistent throughout the project.

Figure 1: Overview of the P4ELECS Project



The work of WP 2 and hence this deliverable, contributes to the encompassing objective of P4ELECS to create "a modular and flexible training offer at the highest European standards and via innovative educational methodologies aimed at the energy transition based on skills needs analysis that can be adapted to the specific educational paths of learners both for initial and up-skilling and re-skilling of adults and including key competences in order to integrate the whole cycle of production from ideation to implementation responding to innovation and markets needs in terms of integration of competences from several EQFs levels" (Project proposal, 2023, p 5). It will help to achieve the overall objective 1 of P4ELECS and more specifically objective 1.2.

Objective 1: High quality provision of educational material for a timely provision of skills and competences in initial and continuous education attuned to labour market needs integrating

designing, developing (engineers) and implementing, operating (technicians) capacities for the smart energy sector. (Project proposal 2023, p. 5)

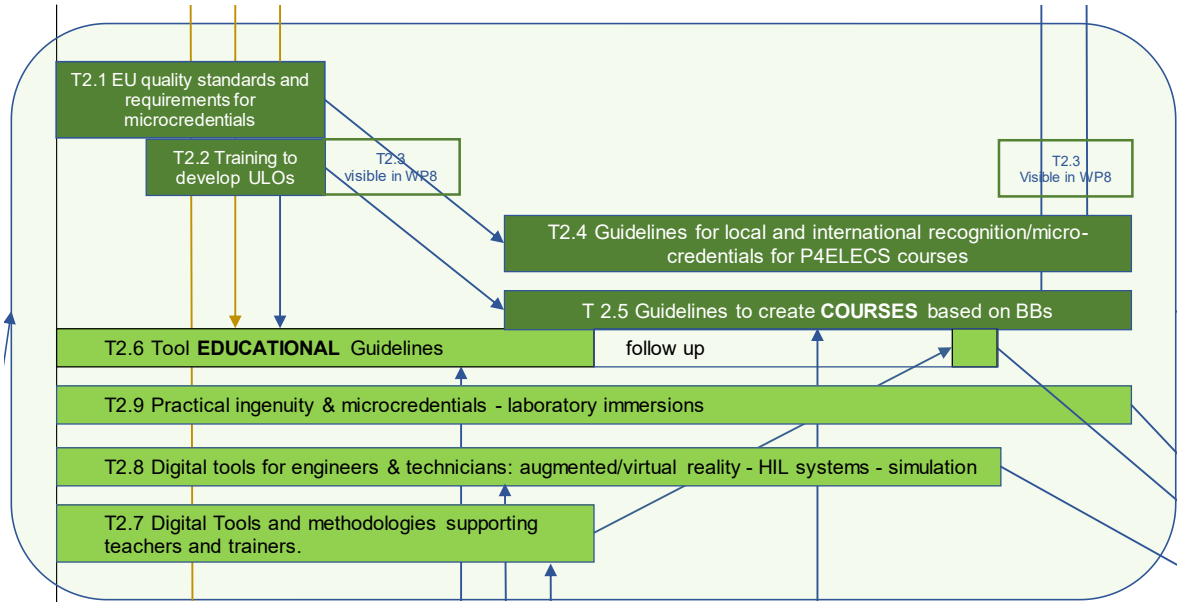
Specific objective 1.2 GUARANTEEING HIGH QUALITY MATERIAL
Guaranteeing High Quality material by providing guidelines for designing and combining blocks, relying on experts (from research, education, industry) as authors, reviewing processes and quality control, aligning with EU requirements for quality, recognition and accreditation (EQAVET, ECVET, ESG 2015, ECTS), with special emphasis on micro-credentials and continuously updating (Project proposal 2023, p.19)

The educational guidelines for the BBs and courses support the development of high quality educational material. The guidelines take the European legislation into account, to guarantee that the material developed meets the EU requirements for recognition and accreditation.

1.2 Outline of the deliverable

This deliverable presents the educational quality guidelines we developed in WP2. Section 2 introduces the distinctive concepts of P4ELECS and explains how we refined our conceptions of these concepts during the project. Section 3 outlines the educational quality criteria for building blocks and courses, followed in Section 4 by the provided guidance to comply with these criteria. This section describes both the overall support provided and the specific support for laboratory sessions. The document concludes with the lessons learned and recommendations in Section 5. This aligns with the tasks outlined in the project proposal (see Figure 2).

Figure 2: Tasks of WP 2



2. Distinctive concepts of P4ELECS

P4ELECS is based on an extensive work to develop a methodology based on the CDIO initiative (Concept Design Implement Operate) initiated by MIT, which is a taxonomy of the skills and competences an engineer of the 21st century should have (http://www.cdio.org/). This new methodology is built around building blocks (BBs), CDIO spiders and the Building Block Platform (BBP).

2.1 Building Blocks (BBs)

2.1.1 Started from the proposal

In the project proposal the **Building Block (BB)** was described as follows:

> A BB is a small piece of content that covers a well-defined topic and provides the answer to a specific question. It can consist of a reader, PPT, video, simulation, assignment, data sheets, lab tutorial, URL's, BB information page, Q&A, …
>
> A BB consists of RAW and VALIDATED information. RAW means the content does not contain publicity and limited pedagogical elements. It is sec information, the extraction of knowledge from papers, reports, manuals, standards, experience and lessons learned from realized projects, … BBs are VALIDATED by EXPERTS from research and industry.
>
> Building Blocks are immediately applicable for education or industry. Teachers can choose the topics and hence the BBs they want to address, integrate them in their courses and keep their pedagogical freedom. Learners (students, employees) can easily find that specific part of information they need for their projects, electives or to improve their qualifications (upskilling, reskilling).
>
> BBs are necessary to foresee enough flexibility to develop tailer-made courses for individual learners/teachers. The parts BBs contain offer the possibility to comply with educational guidelines.

2.1.2 During the development of the guidelines

CLARIFICATION IN THE DESCRIPTION OF A BB

In the development process of the educational guidelines for BBs refinements or clarifications in the concept of BBs were added.

1. **Different users of a BB can be identified**

- Teachers who want to use (part of) a BB in their courses, or
- Individual learners who want to update this knowledge and skills, or who are curious about something. Those individual learners could be professionals or students in an educational programme. The individual learners are very self-regulated and can learn very independently

Rationale: The identification of different users was essential to be able to define clear guidelines. Individual learners are expected to be very self-regulated because the BB has limited pedagogical elements.

2. **A BB consist of descriptors and elements**

- Descriptors: explaining the main characteristics of a building block, such as the learning outcomes, EQF-level, …
- Elements: subcomponents of a building block about the topic of the BB (e.g. a presentation, an instructional text, a video, an exercise, …). Elements can be selected by a user.

Rationale: This distinction made structuring a BB easier. The descriptors make it possible to search for an appropriate BB. The descriptors enable an appropriate BB to be found. The elements make the BB flexible to use. For example, a teacher could choose to use only the 'exercise' element, while a professional could decide to study only the 'reader' element.

3. **Each BB consist of at least**

- **One content related element (e.g. a presentation, a text)**
- **A self-assessment with an answer key, covering the whole BB**
- **A file with references**

Rationale:

- The self-assessment is essential for an individual learner to be able to test to what extent (s)he masters the BB. It is also helpful for a teacher to assess the BB or to get inspired for evaluation questions.
- The references are an indication for the quality of the BB and the extent that the BB makes use of recent information. It is also a source of additional information for users.
- At least one element on the topic of the BB is needed to support the learning of the learner.

4. **A BB should leave as much freedom as possible to teachers to use a building block or a selected element in the way the teacher prefers**. This implies that the educational elements need to be limited but at the same time sufficient for the individual learner.

Rationale: The freedom is essential for the usability of a BB by teachers. For the BB-developer and for the quality guidelines, providing this freedom requires a delicate balance between offering sufficient support to the individual learner and not too much in order to stimulate the usability for teachers. This highlights the relevance of the self-regulation and independent learning (see 1).

5. **Although a BB is intended to stimulate learning, processing a BB will not result in a proof of learning.** An individual learner who processes a BB will not be granted a certificate.

Rationale: A BB is learning material, to support learning. It does not involve a formal summative evaluation. This is a very important distinction with a course (see 2.3).

DIFFERENT TYPES OF ELEMENTS

To structure the development of elements, different types of elements were selected to be used in P4ELECS (see Table 1).

Table 1: Description of the Different Types of Elements

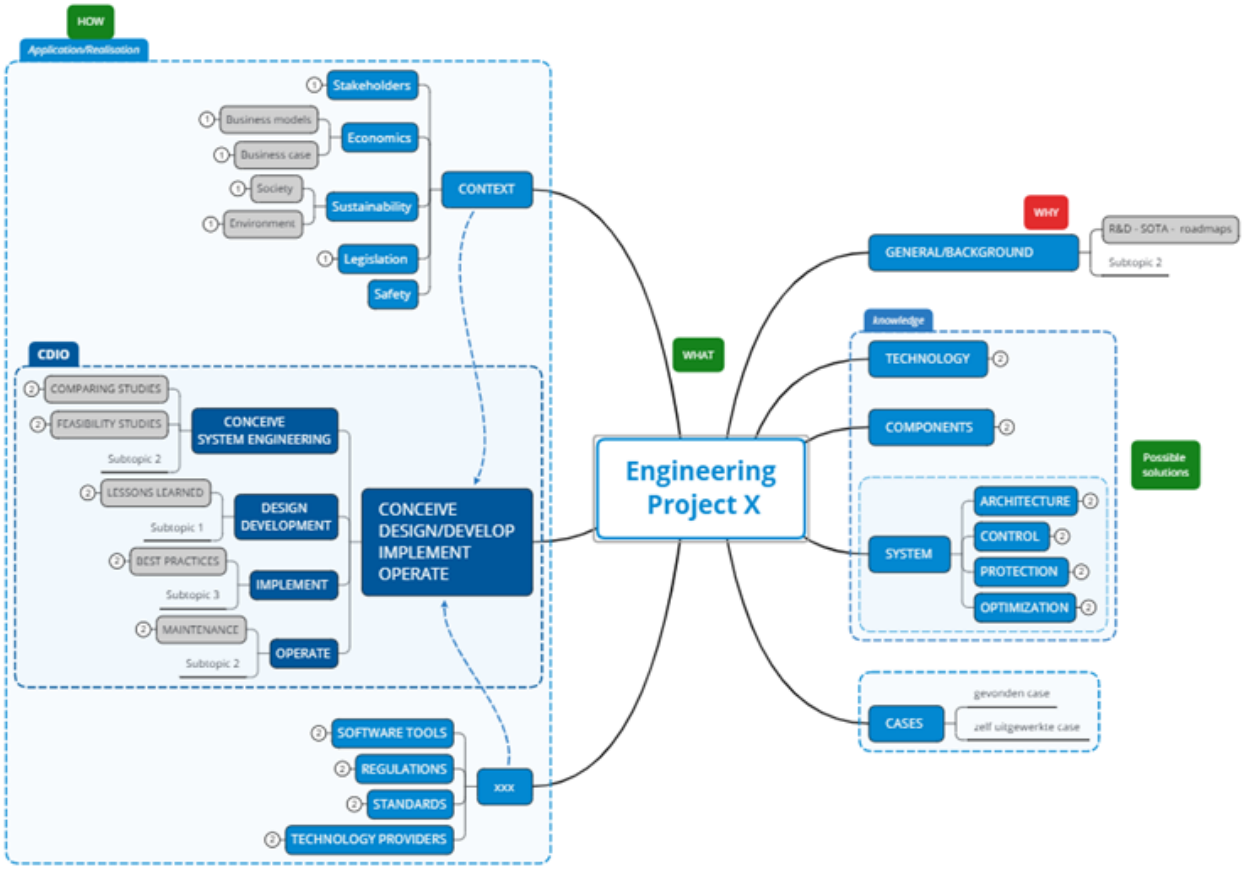
Nr	Name element	Description
1	Reader	A reader is an instructional text; it is a written text that can be printed or studied digitally. It can be combined with tables, figures, schemes, pictures, … It is more than only words written in a text. It meets two requirements: - The content is based on an in-depth and up to date knowledge of the topic, and - The format is stimulating for student learning.
2	Presentation	A presentation is a visual and textual communication offering designed to convey information, ideas or instructions. It can be delivered live to an audience or studied independently at a learner's own pace. A presentation is more than just a collection of slides. It is a structured way of guiding attention and enhancing comprehension through design and delivery.
2	Videos and knowledge clips	A knowledge clip is a short video of max 6 min to explain a specific concept, principle or skill. A video is a movie about a specific topic. It can take different forms, like a documentary on a specific topic or an audiovisual recording of a part of a lecture.
4	Podcasts	A podcast is an audio program on a specific topic.
5	Exercises	An exercise is a task designed to help students practice or apply something they are learning. It allows learners to develop their knowledge and skills.
6	Simulations	A simulation is an activity that imitates a real-life situation or a process. It helps students to practice for complex situations. Often specific software is used.
7	Assignments	An assignment is a task given to students to test if they have learned something. It can concern a small part of a BB or a specific part. When it covers the whole BB, it is a self-assessment (9)
8	Data	Data are information. Data are given to students to practices within an exercise, simulation or assignment.
9	Self-assessment	A self-assessment is a (set of) question(s), an assignment, a task that learners can use to test if they master the learning outcomes of the whole BB. The self-assessment covers all the learning outcomes of the BB.
10	References	The references include all the material that is used to develop the BB.

2.2 CDIO-spiders

Building Blocks are grouped in so-called "**CDIO spiders**" (see Figure 3). Spiders are thematic clusters of BBs, organized according to the CDIO-approach (http://www.cdio.org). This approach, initiated by the Massachusetts Institute of Technology (MIT) is a taxonomy of the skills and

competences an engineer of the 21st century should have. These competences are ordered in four categories: Conceive, Design, Implement and Operate.

Figure 3: Example of a CDIO-Spider



In the project proposals spiders are described as follows (Project proposal, p. 22)

> Spiders are linked to the realization of a project (e.g. a microgrid, a smart building, a charging station, an electric vehicle etc) and cover all the aspects from design to implementation. The categories in which BBs can be classified is based on the CDIO taxonomy. This combination of the CDIO taxonomy and grouping of educational materials is a first of its kind for Electrical Engineering. This approach can however be expanded to other engineering disciplines. CDIO-spiders will follow the timeline of emerging and emerged technologies. For emerging technologies mostly knowledge BB will be available. For emerged technologies mostly design BB and implementation/operation BBs will be developed taking into account standardization and legislation. Therefore the CDIO-spiders and the BBP are very dynamic and provide the state of the art knowledge and support of requested skills. CDIO spiders relate the blocks in such a way that users (learners, teachers, Spider Coordinators, possible authors of BBs) have a good overview of available but also lacking information.
>
> Research oriented institutions, industry and VET-providers need to collaborate more intensively and on a much larger scale, to provide the necessary knowledge to develop and sustain these spiders. The level of collaboration required is innovative as well.

CDIO-spiders offer a NEW structure to support the collaboration between stakeholders of the knowledge triangle in the skills ecosystems to cocreate the materials needed for a timely skills adaptation.

It is important to note that the CDIO-based spider structure also supports the P4ELECS ambition to facilitate cooperation between VET and Higher Education (EQF level 5, 6 and 7), as it allows learning content to be positioned along increasing levels of complexity, responsibility and practical application, while maintaining a shared conceptual framework across educational levels. It adds to the VET-HEI handshake.

2.3 Courses

Courses are another distinctive concept in the P4ELECS project. BBs can be used in courses. Within the P4ELECS project about 20 international courses will be developed using the developed BBs. Courses are not explicitly defined in the project proposal. Courses are part of the flexible training which the project aims to offer at the highest quality and European standards via a user-centric platform (see e.g. p. 2).

DIFFERENT TYPES OF COURSES

When developing the quality criteria for courses, it quickly became apparent that different types of courses could be developed using the BBs, with different consequences. Therefore, we made a distinction between institutional courses and P4ELECS courses. The similarities and differences are explained in Table 2.

Table 2: Institutional Courses and P4ELECS courses

Topic	Institutional courses	P4ELECS courses
Use (elements) of BBs	• Yes • Possibility to make use of a clone of a P4ELECS course	• Yes
Access for the student	• Via the learning management system of the institute.	• Via the Building Block Platform (BBP)
Availability	• Open for students of the teacher who decides to use the BBs	• Open for learners from within or outside of the organising institution. • Interested learners can have look at the course description (on the BBP + institutional announcements). • Registered learners have access to the material via the CP during the course
Recognition of the learning	• Yes (depending on the rules of the institution) • In the own institute	• Yes (and only if the assessment was successful) (a formal assessment is always part of the course) • The organising institute issues the recognition. • The earned recognition can possibly be used in the curriculum of a student or be recognised by a professional association

Place	• Choice of the institution	• Always included a hand-on part, often combined with online elements
Organiser/ Type of institution	• HEI, professional training body, company training institute	• Always in cooperation with a HEI

Both types of courses make use of BBs or elements of BBs of P4ELECS. The BBs are accessed through the BBP (see 2.4) and integrated in the learning management system of the own institution. The users do not necessarily know that they use a BB.

The two types differ in the kind of students aimed at: While the institutional course aims at the own students, the P4ELECS course aims at a broader public, often an international public. Of course, the own students can participate but it is always open to others, who are actively invited to participate, e.g. in the framework of a Blended Intensive Program (BIP). On the BBP the offered courses are also made public. Both types of courses result in a recognition of the learning, but in an institutional course, that kind of recognition and the criteria for that recognition depend on the institution. It is for example possible that a learner gets a recognition of participation without the formal assessment. In a P4ELECS course a formal assessment is always part of the course and it always results in a formal recognition, e.g. in a certificate, a credit, a microcredential, a badge, … That formal recognition can be transferred to another institution. The acceptance is always the responsibility of the accepting institution. But the name 'P4ELECS-course' could act as a label in the acceptance of the formal recognition.

All the above implies that an institutional course operates within the boundaries of the own organisation while a P4ELECS course has additional requirements to fulfil in order to be labelled as a 'P4ELECS course'. This labelling could act as a quality label of the course and the learning that took place.

It is important to note that both types of courses are valuable for the project and hence stimulated. Both types of courses use BBs, which the project aims for. With the institutional courses the potential use of BBs is immense, it can serve learners from all over the globe. The way BBs are used, how students are taught or evaluated within an institutional course is out of the control of P4ELECS. Therefore, the educational quality guidelines for courses can not apply to these institutional courses but only to the P4ELECS courses.

CLARIFICATION IN THE DESCRIPTION OF A P4ELECS-COURSE

During the development of quality criteria for P4ELECS courses a description of what a P4ELECS course could be, was developed.

1. **For each P4ELECS-course there is a description, that follows the requirements for a microcredential**

Rationale: Our goal is to achieve international recognition for the P4ELECS course. Therefore, complying with European microcredential rules is valuable because it increases the likelihood of international acceptance.

2. **Each P4ELECS-course consists of at least**

- **One BB**

- **A 'physical' element (e.g. a hands-on lab)**
- **An assessment of the learning of the student**

Rationale:

- The use of at least one BB is a way to guaranty the quality of the learning material.
- The physical element helps the student(s) and the teacher to meet each other and stimulate learning.
- The assessment is an indication of what a student knows/can at the end of the course.
- The course-designer has freedom to design the course to what is considered needed and feasible (e.g. type of assessment, length, credits, ….).

3. **A P4ELECS-course leads to a formal recognition of learning based on an assessment**

Rationale: A P4ELECS course includes an act of teaching and assessment. There is a formal registration of what the student knows/can after the course. The formal recognition of learning is an important distinction between a BB and a P4ELECS course.

4. **There are different defined users of a P4ELECS course**

- Professional who want to update his knowledge and skills and who want a proof it
- Student who want to learn the learning outcomes of the course/ a student for who the course is part of the obliged curriculum
- Teachers who want to know more about the content of the course or how you can teach it.

Rationale: The identification of different user was essential to be able to define clear guidelines.

2.4 Building Block Platform (BBP)

A fourth distinctive concept in P4ELECs is the Building Block Platform. That is an IT-platform where BBs and courses are made available.

In the project proposal it was described as:

> Building Blocks are grouped in so-called "CDIO spiders". Spiders are linked to the realization of a project (e.g. a microgrid, a smart building, a charging station, an electric vehicle etc) and cover all the aspects from design to implementation. The categories in which BBs can be classified is based on the CDIO taxonomy. This combination of the CDIO taxonomy and grouping of educational materials is a first of its kind for Electrical Engineering. This approach can however be expanded to other engineering disciplines.
>
> **The main services are:**

1. the **Building Block Configurator** that contains all the necessary information to identify content, required prior knowledge, work load, learning outcomes, the courses or micro-credentials the BB is already associated with etc.
2. the **Catalogue** with the Building Blocks and CDIO-Spiders
3. the **Course Configurator** to compile building blocks into tailer-made courses
4. Quality control system (peer review, content & educational quality, recognition (micro-credential, certificate, accreditation))

The BBP is an innovative service to teachers and learners and supports Life Long Learning, reskilling &
upskilling. It allows everybody worldwide easy access to knowledge/experts at any time at any place.

The BBP is a way to access and distribute the BBs and courses.

3. Educational quality criteria for BBs and courses

3.1 Introduction

The educational guidelines for the BBs and the guidelines for courses are intended to support the development of high-quality educational material. The guidelines take the European legislation into account, to guarantee that the material developed meets the EU requirements for recognition and accreditation.

When working on the educational guidelines it became apparent that developing a BB and a P4ELECS courses is a very complex and demanding process. Many BB-developers and course designers have very limited formal educational training. Often they work intuitively and have difficulties to understand educational concepts even when they apply them in reality. This makes it hard to understand criteria. BB-developers and course designers need clear criteria and abundant support when developing their BB or course. In the criteria and educational support concepts need to be explained clearly.

The decision was therefore taken make in the written educational guidelines a distinction between *educational quality criteria* and *quicksheets*. The introduction of quicksheets was a direct response to user- and partner feedback, demonstrating an active quality monitoring and improvement cycle in line with the project's quality approach.

- The *educational quality criteria* were confined to a limited set of criteria and short explanations, ordered in different tables, each consisting of a limited set of criteria, a one-line explanation, tips and suggestions.
- In a *quicksheet*, a single topic is explained, with illustrative examples and supportive tips and a series of recommendations for further reading. A quicksheet may be associated with a descriptor (e.g. EQF level), a specific element (e.g. self-assessment), or an overarching topic (e.g. intellectual property). All quicksheets follow a similar structure: about, step-by-steps guidelines, tips, literature. Based on anticipated or noticed needs, additional quicksheets were developed (See 4.1).

3.2 Educational quality criteria for BB

In the project educational quality criteria are developed. These were developed in different iterations. Different versions were presented and discussed at the general meetings. Based on the feedback of BB-developers and our experience with offering support to BB-developers and reviewing BB adaptation and improvements to the criteria were made.

The final version of the educational guidelines for BBs is added in Annex 1 and are discussed here with some additional information. They are organised in three parts:

1. Educational quality criteria for BB descriptors
2. Educational quality criteria for the elements: overall criteria
3. Educational quality criteria for self-assessment.

It is evident that the educational quality guidelines are subject to continuous development in response to the evolution of educational sciences and educational technology, as well as potential alterations to the BBP. To illustrate this point, consider the impact of Generative AI on the future organisation of education, with a particular focus on different ways to support the learning of the learners.

3.2.1 Educational quality criteria BB-descriptors/BB ID

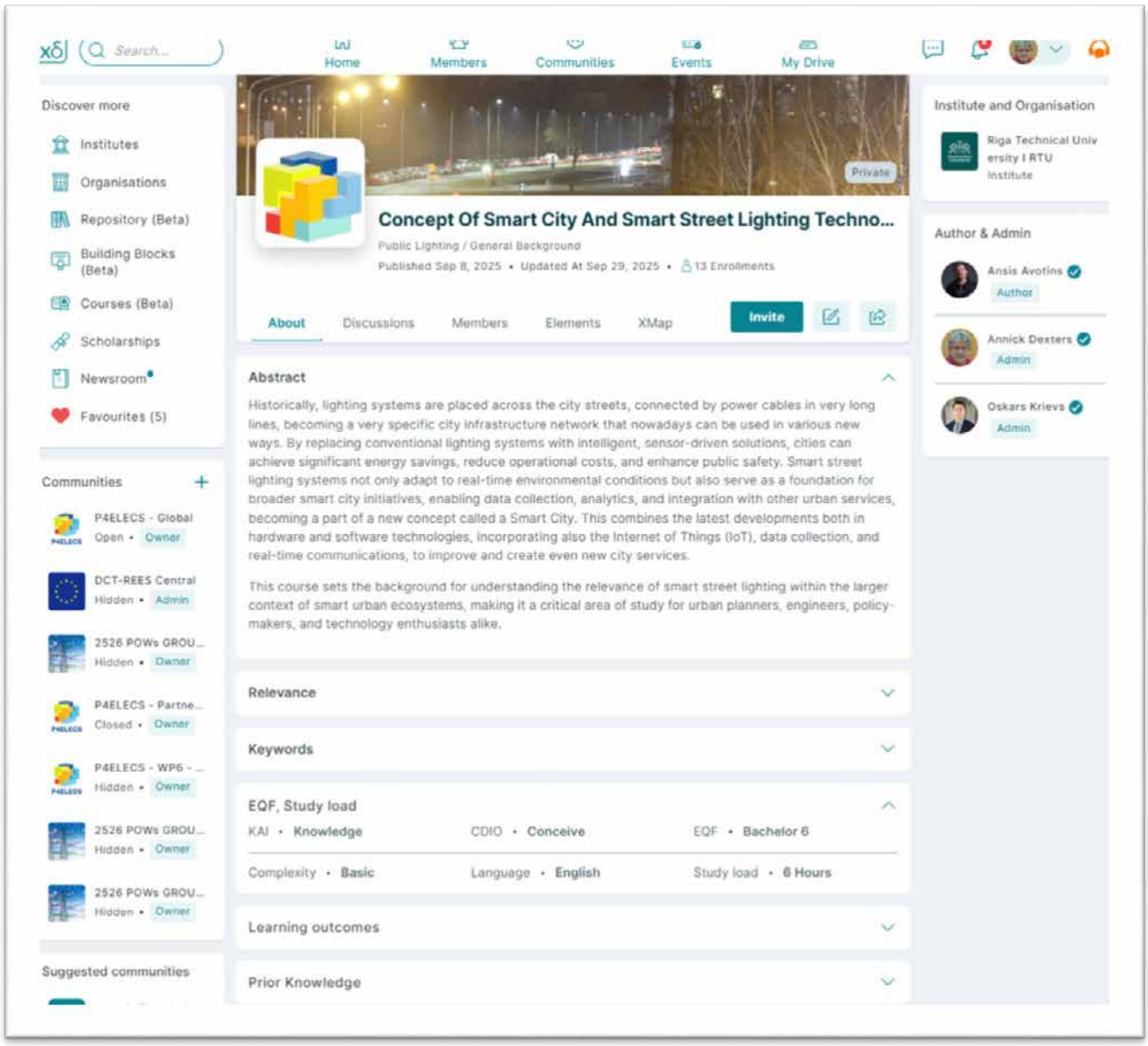
It is important that BBs can be found by the users in the Building Block Platform. To compose courses with BBs it is also important that certain information is provided, in order to apply for a microcredential, for example. This information is provided in the BB-descriptor.

The descriptors of a BB are shown in the BBP (see Figure 4), when searching for a BB.

In order to select the appropriate descriptors, the team studied EU-requirements and regulations for quality, recognition and accreditation, such as

1. General European regulations such as the European Qualification framework (EQF) (for education in general), the European Credits Transfer System (ECTS), the European Standards and Guidelines of 2015 in the European Higher Education Area (ESG 2015), most of them related to work of the European Association for Quality assurance in Higher Education (ENQA) to realise the European Higher Education Area (EHEA).
2. European organisations and regulations focusing on Vocational education and training (VET) Education, because P4ELECS aims at realising a handshake between VET and Higher Education, such as the European Centre for the development of professional training (CEDEFOP), the European Quality Assurance Reference Framework for vocational education (EQAVET); European credit system for vocational education and training (ECVET),
3. Specific regulations on micro-credentials (MCs), also for VET.

Figure 4: Screenshot of the descriptors of a BB in the BBP



The educational quality criteria for BB descriptors/BB ID are described in Table 3.

Table 3: Educational Quality Criteria for BB descriptors/BB ID

Descriptor	Criterium	Explanation, tips, possible ways to do or check it (among others), examples or rules of thumb
Title	The title captures the **essence** of the BB. (max 55 characters)	Possible ways to do or check it - The words used in the title are also used in the learning outcomes, abstract and hashtags
Relevance	The relevance of the BB for the learner is made clear	Possible ways to do or check it - There is an explanation of where to topic of the BB is used

	(max 150 words, preferably 100)	- An example of the application of the BB is given
Abstract	The abstract **summarises the content**, with more detail than the title. (max 150, preferably 100)	
Keywords/ hashtags	The keywords are **in line with** the abstract. (max 10)	Tip - Include the keywords and hashtags in the abstract or formulation of the learning outcomes
	The keywords are **in line with** the learning outcomes.	
KAI	The indication of Knowledge, Application or Implementation is **appropriate.**	*See quick sheet learning outcomes*
CDIO	The indication of Conceive, Design, Implementation or Operation is **appropriate.**	Tip - Often the distinction between conceive versus design and between implementation versus operation is not easy to make. If you cannot choose, indicate only KAI. *See quick sheet learning outcomes*
Level Basic, intermediate, advanced	The indication if the BB is at basic, intermediate or advanced level is **appropriate.**	

Learning outcomes	The list of learning outcomes is **short** enough.	Rule of thumb
		- Max 6 learning outcomes. If you have more, consider
		  ○ formulating learning outcomes on a higher collective level. E.g. *the student is able to install a PV installation and comply with all the requirements* instead of listing the different requirements in separate learning outcomes
		  ○ dividing it into different BBs.
		See quick sheet learning outcomes and quick sheet Taxonomy of Bloom

	The learning outcomes are formulated according to **Subject + Action verb + Object + Context.**	Examples - The learner (=subject) can draw (=action verb) a schematic representation of how the different components interact (=object). - The learner (=subject) can predict (=action verb) the possibilities and limitations of a pv trailer(=object) based on design choices (=context). *See quick sheet learning outcomes and quick sheet Taxonomy of Bloom*
Prior knowledge	The expected prior knowledge (knowledge, skills, …) that is assumed to be mastered before starting this BB is **formulated with sufficient detail.**	Example - Learners can explain the difference between AC and DC (That is more detailed than “Learners *are familiar* with the *basic* concepts of electricity, learners know *enough* basic concepts”) Tip - Only include what is really needed. E.g. only include ‘apply Faraday's law’ if it is actually needed. *See quick sheet prior knowledge*
	The expected prior knowledge is **understandable** for the learners	Tips - Avoid abbreviations,

	and they can assess if they comply with it.	- Avoid local references (e.g. not: Learners reached mathematics at level 5c.) - Be precise and avoid vague/general words, like 'learners know enough basics concepts of electricity' *See quick sheet prior knowledge*
Elements	There is a clear **list** of the different elements included in the BB.	*See quick sheets Designing laboratory sessions, instructional text, working model, effective presentation slides, asking questions, knowledge clips*
	The **relation** between the different elements is made **clear**.	Possible ways to do or check it - A scheme is included to explain the function of each element and the presumed order of processing the different elements (e.g. first the instructional text or the video, then the exercises, then the simulation, …
	The element 'References' is included.	
EQF level	The **appropriate EQF** level(s) is (are) indicated.	*See quick sheet EQF*
Estimated average study load in hours	Given the expected prior knowledge, the estimation of the average study load for all the learning outcomes of the BB is reasonable.	Rule of thumb - Think how long it would take to cover the content in class, then multiply that figure by three.

3.2.2 Educational quality criteria for the elements: overall criteria

The education quality criteria for the elements are described in Table 4, which concerns all elements except self-assessment. Initially we considered creating a set of criteria for each type of element (such as a reader, a video, …), specifically geared towards that specific element (e.g. about the readability of the font in a reader). However, this option was discarded due to its complexity. It would be difficult for BB-developers to gain an overview of the expectations. We wanted guidelines that could easily be understood by the BB-developers.

Table 4: Educational Quality Criteria for the Elements: Overall Criteria

Criterium **(always under the assumption that the learners comply with the prior knowledge)**	**Explanations, tips, possible ways to do or check it (among others), examples or rules of thumb**
Everything addressed in the element is focused on the learning outcomes (1-5), taking the prior knowledge into account and the learners know why every part is relevant in achieving these learning outcomes (1,2,4)	
1. The element is **relevant and sufficient for achieving (part of) the learning outcomes**.	Possible ways to do or check it (among others) - The content is focused on the topic at stake. - The information provided is enough to attain the learning outcomes. - The exercises are helpful in grasping the content, in attaining the learning outcomes. *See quick sheet learning outcomes*
2. The element is **concise.**	Possible ways to do or check it (among others) - All the information included is needed. - Every part has its function in relation to the learning outcomes.

3. The **relevance** of the overall topic/content and the subtopics is made **clear** for the learner.	Possible ways to do or check it (among others) - There is a short explanation of what will be learned and why it is important, e.g in a professional context. - The relevance is made clear with a concrete, real world example. - A picture is included of the application at stake. - The learners understand the examples or cases included. If needed, a case or example is situated, for the learner to understand its function in the text. - Each module/section clearly indicates why this content is important for professional practice. - The connection with real vocational situations is made explicit. - There are answers to questions like: "Why do I need to know this?" and "How can I use this in practice?". - The content is linked to tangible, real-world projects. - Exercises result in something students can be proud of. - Examples show how the knowledge is applied in professional contexts that the learners know. - Content explains how the skills will be used in the workplace. Example - 'Now we will focus on X because …'. 'In the previous chapter, we saw that W is important. In this chapter we investigate the characteristics of W, …'
4. (If applicable) If the element is focussing on specific learning outcomes of the BB, those **learning outcomes** are made **clear**.	Possible ways to do or check it (among others) - There is a list of the relevant learning outcomes. - At the end of each chapter there is a box titled 'What should you be able to answer after processing this chapter?'
5. The content is **adapted to** the expected **prior knowledge**.	Possible ways to do or check it (among others) - Concepts/formulas/ … that are assumed to be prior knowledge are not explained again. - New concepts are explained, including their relationships with other known concepts (ie prior knowledge), with examples provided where appropriate. - If learners have to use a new tool (e.g. simulation tool), the way to work with it is explained. The first exercise, for example, is designed to familiarise the learner with the tool. The next exercises become progressively more difficult. *See quick sheet prior knowledge*
The learners are guided in navigating through the learning material by using structuring (6), supporting (7,8,9,10) and directing aspects (11,12)	
6. The **structuring aspects** are **relevant and sufficient** for the learner. (e.g. introduction, table of contents, …)	Tip - Instructional text: A table of content is not necessary for a short text of two pages. In a long text, with different sublevels, a detailed table of contents becomes important (e.g., not only the titles at level 1 are listed, but also the levels below). *See quick instructional text, intellectual property & powerful visuals*
7. The **supporting aspects** are **relevant and sufficient** for the learner. (e.g. videos, graphs, schemes, examples)	Possible ways to do or check it (among others) - The graphs/examples/… included add to the understanding of the topic at stake. - For more difficult relationships, a scheme is provided, while this is not the case for easier relationships.

	- In a video a process is demonstrated live (e.g. a shot of a working wind turbine) or with a schematic representation. Rule of thumb - A knowledge clip is not longer than 6 minutes. Longer videos (+6 min) are hard for learners to stay focussed. They need additional educational interventions for the learner to stay focussed (e.g. questions, …) Tip - Video: Reconsider splitting up a longer video into different smaller videos to facilitate learning. Different short videos are easier to process and to learn from than a long video. - Make chapters in your video *See quick sheet multimedia principles, instructional text*
8. The **supporting aspects** are **linked** clearly to the text/explanation.	Possible ways to do or check it (among others) - In an instructional text the graphs are close to the relevant paragraph and in the text, reference is made to each graph. - In presentation slides the relation with the explanation and the scheme is clear. *See quick sheet multimedia principles, instructional text*

9. The learner is **guided in focusing** on the relevant aspects of visual material.	Possible ways to do or check it (among others)
	- In an instructional text, the important elements in the graph are indicated (e.g. 'This is shown in part B of Figure 1')
	- In a video or presentation slides
	  o The aspect of the graph being discussed is lighted or circled, …
	  o When explaining a process, the consecutive elements are highlighted, …
	- In presentation slides without video, the explanation of a process is spread over different slides, where the learner can see the different steps in the process.

10. The layout is **supportive** for the learner	Explanation - The layout helps the learner to understand the structure of the material and the relationships between the different parts. Possible ways to do or check it (among others) - The layout is self-explanatory (e.g. Title 1.2.1 is a subtopic of Title 1.2) - The logic of the layout is explained. E.g. examples are in grey boxes, exercises are in frames, and the answers are at the end of the presentation slides/instructional text, …
11. The **directing aspects** are **relevant and sufficient** for the learner. (E.g. learning outcomes, questions, exercises…)	Explanation - The directing aspects help the learner process the information without taking over that they are capable of doing independently. - The directing aspects help to maintain the motivation of the learner. Possible ways to do or check it (among others) - Exercises are chosen to draw attention to topics that learners often find difficult (misconceptions/challenging topics). - New procedures and rules are explained and contextualised (when to use them and when not to). - Exercises are at the right level of difficulty. - For VET students: - Exercises produce a tangible result.

	- Assignments demonstrate direct applicability in professional practice. Learners can translate what they've done in the exercise into concrete actions in their future work environment. - Exercises are connected to the local environment (e.g. learners have to repair something in their own home, create something in the public domain, …) *See quick sheet multimedia principles, instructional text, asking questions*
12. **(**If applicable) The directing aspects are linked to the other elements of the BB	Possible ways to do or check it (among others) - In an instructional text reference is made to additional exercises in the element 'exercises' of the BB, or to a video explaining how to apply certain principles. - In presentation slides the relevant knowledge clips are mentioned.
The used language supports understanding (13)	

13. The used **language** is **adequate.**	Possible ways to do or check it (among others)
	- The level of complexity of the language is adapted (the vocabulary used is not too difficult for the learner).
	- The tone of voice is appealing (the learner is addressed directly, E.g. 'you will, …', passive voice is avoided).
	- Abbreviations are explained.
	- Synonyms are explained explicitly or avoided.
	- In a video a story is told (rather than written text being spoken aloud), with for example:
	  ○ There is a clear voice-over that guides the learner through the content.
	  ○ There is a presenter who talks directly into the camera.
	Rules of thumb for a video
	- The use of written text is limited to the essentials.
	- The written text is consistent with the spoken language, with the written words (mostly main concepts and key words) also included in the spoken text (e.g. avoid writing 'vehicle' and saying 'car').
	See quick sheet multimedia principles

3.2.3 Educational quality criteria for self-assessment

A specific set of educational quality criteria for self-assessments were developed (see Table 5). The criteria are too specific to be included in the overall criteria.

Table 5: Educational Quality Criteria for Self-Assessment

Criterium **(always under the assumption that the learners comply with the prior knowledge)**	**Explanations, tips, possible ways to do or check it (among others), examples or rules of thumb**
1. The self-assessment **covers all the learning outcomes of the BB.**	Explanation - The self-assessment is intended to provide learners with an accurate understanding of their level of mastery of the BB. Therefore the self-assessment should cover all the learning outcomes. Tip - If the learner is required to apply something, include only new exercises (and not exercises used in the BB) as it is only through an unfamiliar exercise that you can ascertain whether the learner can able it with apply. An 'old' exercise could have be memorised.

	See quick sheet self-assessments
2. The learners can do the self-assessment **based on** the topics covered in the different elements of **the BB** and the information provided in the assessment.	Possible ways to do or check it (among others) - There is no need for the learner to look up additional information (unless that is the learning outcome) *See quick sheet self-assessments*
3. All questions are **formulated clearly**.	Possible ways to do or check it (among others) - The tasks that the learner has to complete, are clear (e.g. What is the velocity of X?). - The subdivisions of the questions are clear (e.g. 'a. list 3 advantages, b. list 2 possible problems). - Vague descriptions are avoided (e.g. What can you tell about X and Y?-> Explain how X affects Y?). *See quick sheet self-assessments*
4. The **conditions** under which the learner should answer the self-assessment are clearly described.	Examples - "The learner is (not) allowed to use the material provided." - "The time to finish the assignment is 30 min." (to assess if the learner is fast enough) *See quick sheet self-assessments*
5. It is possible for the learner to **self-assess the correctness** of the answer, with the information provided.	Possible ways to do or check it (among others) - There is an answer key - There is automated feedback *See quick sheet self-assessments*
6. It is possible for the learner to **self-assess the overall quality** of the answers.	Example - "In order to pass, this and that should be included in the answer." - "The first 4 questions are fundamental. If you made a mistake there, you should look at X again. *See quick sheet self-assessments*

3.3 Educational quality criteria for P4ELECS courses

The guidelines consisted of an introduction, and three subdivisions (educational quality criteria for the description of the P4ELECS course, educational quality criteria for the operational phase of the P4ELECS course, and the essential information concerning the learner for the recognition of a microcredential) (see Annex 2). The introduction explains the distinction between the different types of courses, defines a P4ELECS course and outlines the logic of the file. Here we include only the educational quality criteria for the description of a P4ELECS course and for the operational phase of the course. The essential information concerning the learner does not concern educational criteria.

3.3.1 Educational quality criteria for the description of a P4ELECS course

It is important that a course can be found by the users and that is provides the essential information for a learner to make an informed decision. This information is provided in description file of a P4ELECS course (see Table 6).

Table 6: Educational Quality Criteria for the Description of a P4ELECS Course

Descriptor	Criterium	Explanation/Possible ways to do it/Tips/Examples/Rules of thump
Title (MC*[1])	The title makes clear what the course is about (max 55 characters)	Possible ways to do it - Words in the title that are also used in the learning outcomes, abstract and hashtags.
Abstract/ course description	The abstract summarizes the content of the course, with more detail than the title (Max 150 words)	
Keywords	The keywords are **in line with** the abstract and the learning outcomes. (Max)	Tip - Include keywords and hashtags in the abstract or formulation of the learning outcomes.
Relevance	The relevance of the course is made clear	Tip - Explain shortly the importance of the course, why it is interesting and valuable to do the course.
EQF-level (MC) **5-6-7**	The EQF-level is stated	Rule of thumb - If the course can be followed by learners in a degree programme, choose the level of that degree programme. *See quick sheet EQF level*
	The EQF-level fits with the learning outcomes	
Learning outcomes (MC)	The learning outcomes are formulated according to Subject + Action verb + Object (+ Context).	Example - *"*The learner (subject) can identify (action verb) the characteristics and functions of digital communication protocols (object) to ensure interoperability between electrical components and control systems (context)". *See quick sheet learning outcomes and CDIO/KAI and quick sheet taxonomy of Bloom*
	The list of learning outcomes is short enough (not more than 8)	
KAI	The indication of focus on Knowledge, Application or implementation is **appropriate.**	Tip - Often the distinction between conceive versus design and between implementation versus operation is not easy to make. If you cannot choose, indicate only KAI. *See quick sheet learning outcomes and CDIO/KAI*
CDIO	The indication of Conceive, Design, Implement, Operate is **appropriate. (more than one option is possible)**	
Basic, intermediate, advanced	The indication if the course is at basic, intermediate or advanced level is **appropriate.**	Tip - This concerns the depth of the subject of the course. If it is an introduction, it is 'basic'. When it is more advanced, select 'intermediate' and if it is very in-depth, towards the particularities of the subject, select 'advanced'.

[1] Essential information to be available for the recognition of a micro credential (MC) (*see quicksheet Microcredentials*)

Prior knowledge	The prior knowledge is clearly stated, with sufficient detail, and understandable for the learner	Example: - "Learners can explain the difference between AC and DC" (That is more detailed than "Learners are familiar with the basic concepts of electricity, learners know enough basic concepts") Tip: - Only include what is really needed. E.g. only include 'understanding Faraday's law' if the learner needs this to follow the course successfully. - Avoid abbreviations - Avoid local references *(e.g. not: Learners reached mathematics at level 5c* *See quick sheet prior knowledge*
	Suggestions for BBs or courses are given if learners do not comply with the prior knowledge.	
Target learners	There is an indication of who is expected to follow the course.	Example - "This course is for mechanics in the field of domotics who wish to update their knowledge and skill set on …". - "This course is for Bachelor students in Electrical Engineering, who are towards the end of their degree".
ECTS-credits (MC)	The estimated workload is translated in ECTS-credits (1 credit = 25-30 hours of study)	Tip - Check the correctness of the estimated workload, in the feedback from learners who followed the course successfully (hindsight).
Language of instruction (MC)	The language of instruction is indicated	
Assessment approach (MC)	The type of assessment is described (MC)	Example - "Online multiple choice exam, a problem solving task on campus, a practical skills test in the lab, online oral presentation and discussion on a design task, …" Tip - In online assessment parts of the assessment a controlled setting is necessary
	The assessment fits with the learning outcomes	Tip - Make sure the assessment helps to determine if the learner masters the learning outcomes. E.g. if the learner should be able to solve a problem, it is only a start if the learner can list possible causes of a problem.
	There is control of the identity of the student	Explanation - There are precautions to sure that the work being assessed is of the registered student.
Educational approach	There is an explanation about the way the course is organized, what learners' activities are expected and what the provided support is.	Possible ways - There is a timetable, with the classes, preparations, assignments, … - There is an introduction text with the details on the course - There is an explanation about how to process all the material (e.g. First exercise 1, than presentation, then again exercise 1, with in addition simulation A, …)

	The educational approach supports the learning of the learners, towards the learning outcomes.	Example If the learning outcomes is that the learner is able to design something, the course provides examples of designs, analysis of the quality of a design, opportunities to design with feedback, …
	The educational approach fits with the way the course is organised	Example - If the course is self-paced independent learning with a final exam, a lot of support, step-by-step exercises and automated feedback are integrated in the course.
BBs used	There is a list of (elements of) BBs used.	Explanation - At least one BB is included
	The (elements of) BBs used, are suitable for the learning outcomes.	Ways to do or check it - The selected elements/BB are working towards the same/similar learning outcomes as the course.
Other material	There is a description of the material used (books, other material, resources…)	Rule of thumb - Make only new material if there is no suitable BB/element available Tip - Make clear what the function of each material is and how the different material relate
Location	There is an indication where the teaching takes place (online, on campus, both)	
Timeline	There is a timeline of the teaching and learning activities of the course and the assessment, with an indication of the locations	
	If applicable: The time on campus is functional and well in line with other activities	Rule of thumb - The time on campus is only used for activities that cannot be done as good somewhere/sometime else (E.g. for mature learners mere explanations are prepared by the learners at home. In class, there is time for clarification, discussion, application, … If learners are not able to process information themselves, then it is appropriate to devote time to it in class.
Further courses	If applicable: Suggestions for relevant follow-up courses or BBs are given.	
Administrative issues concerning the course (MC)	Information on the 'issuer' (the organizer of the course) (country, name, legal address, memberships)	
	Quality assurance approach (the accreditation of the organization)	Rule of thumb - If possible, include an HEI as an organiser (because then the quality assurance is recognized)

3.3.2 Educational quality criteria for the operational phase of the course

During the enactment of the course, it is important to create conditions that stimulate student learning. This is explained in Table 7.

Table 7: Educational Quality Criteria for the Operational Phase of a P4ELECS Course

Descriptor	Criterium	Explanation/Possible ways to do it/Tips/Examples/Rules of thump
Organisation	The timeline of the teaching and learning activities and of the assessment is clearly communicated	Possible ways - There is a timeline communicated, the timeline includes the assessment - The learning environment is built up according to the weeks of the semester, making clear what is expected - The teachers are briefly introduced
	The timeline is followed	Tips - In the event that the timing has to change, this is clearly communicated
	Communication channels are well-defined and easy to use.	Possible ways - The learners know where to find the course information (eg. In BBP, email, jupyter, …) One primary communication channel is used (e.g. emails, teams, BBP, …)
Off campus teaching and learning	The expected activities/outputs of the learner are made clear to the learner.	Tips - Assignments, preparations (eg reading X, preparing exercise Y,…) are explained clearly
	The activities that the learner has to do, are functional for the learning outcomes	Tips - The cognitive activity the learner has to do, advances towards the intended learning outcomes (e.g. if the learning outcome is to be able to use a concept, then after explaining a concept, an exercise is done to apply the concept or an example is given on the application of the concept)
	The relevance of the activities is clear for the learner	Possible ways - There is an explanation of the reason of the activity 'You have to read a text in order to…, you do this exercise to learn how to… - Practical relevance/the application of what will be learned, is made clear with an example
	The learner gets feedback on the quality of the performed activities	Tips - Individual feedback is only one of the options to give feedback, other options could be an answer key, an overview of often made mistakes, a worked-out example with an explanation of what is good and what could be better. - Adapt the feedback to the type of teaching (online – face-to-face) - Consider if you can make use of GenAI to generate feedback
On campus teaching and learning	The presence on campus has an added value for the learner and is functional for the learning outcomes.	Tips - Social presence is beneficial for motivation. This can be an argument to do some sessions on campus, even if it were possible to do it online - Make optimal use of the infrastructure - Stick to the planned activities even if learners did not attempt to do the necessary preparations (e.g. do not explain the basic concepts, do not give time to figure out the right settings for a tool if they should have done it in advance, …). If unsafe situations could occur, remove learners from the class. The reason to stick to the plan, is to point to the responsibility of the learner and the make sure

		that the time on campus has an added value, for all learners, also those who were prepared. ○ If learners got stuck in their preparation, the teacher tries to help them.
	The learner knows what to prepare, and what to do on campus.	Tips - Assignments, preparations (eg reading X, preparing exercise Y,…) are explained clearly
	The learner gets feedback on the quality of the performed activities, in relation to the learning outcomes.	Tips - Different ways are possible, e.g. discuss one answer of a learner in plenum, discussions in pairs or groups on the answer, compare the own answer with a provided answer, …
Assessment (to grant a credit)	The assessment makes a fair judgment of the capabilities of the learner possible. (The assessment approach guarantees that it assesses the capabilities of the learner fairly (is robust against cheating + robust against biases)	Tips - The conditions are controlled enough to be sure that the work of the learner is assessed, e.g. in an online setting consider online proctoring, when learners need to submit something, include check to ensure that the learner is a author, … - The setting is comfortable (e.g. temperature, noise, movement in the class, time pressure …) and mirror future application (e.g. if the future activity will have to be done in a very busy, noisy environment, it is less a problem is the current setting in noisy. - Avoid dependence on co-learners if possible (e.g. in a lab)
	Assessment criteria are clear	Tip - Make sure the learner knows the criteria of the assessment, by e.g. give an example, provide an evaluation rubric, …
	The learner can receive feedback on the assessment	Tip - Organise collective feedback on common mistakes
Feedback of the learner on the course	The learner can give feedback on the course	Tip - A standard survey is offered at the BBP.
	Make use of the results of the standard feedback questionnaire to adapt your course	

4. Educational guidance for BB-developers and course designers

Throughout the first two years of the project, it became clear that developing educational materials is a complex process. Many developers involved in this work do not have formal training in education and therefore have a limited educational vocabulary. However, this limitation is often compensated for by their practical experience in educational settings and their strong ability to translate newly acquired insights into practice when these are explained clearly. Given their limited time, BB developers and course designers also needed clear guidance and support to understand the expectations placed upon them.

Therefore, a lot of attention and effort is invested in support for BB-developers and course designers.

4.1 Quick sheets

During the project different quicksheets were developed to support the BB-developers and course designers.

In a quicksheet a single topic is explained. It is written in a way that it can be read quickly and that it is at the same time very informative, due to clear examples and helpful tips. It should give the reader a quick overview of the topic with the most important aspects to take in mind.
Each quicksheet follows a similar structure: about, step-by-steps guidelines, tip and literature.

The quicksheets cover different topics (see Table 8). Some explain the rationale and background of certain descriptors (E.g. EQF-level, learning outcomes). Others focus on an element such as self-assessment, instructional text, presentations or lab sessions. A final category are topics that are more overarching (such as intellectual property, powerful visuals). All quicksheets are added in Annex 3.

Table 8: Overview of the Quick Sheets

Topic	Full name
Descriptors	
Learning outcomes	How to set up learning outcomes and CDIO and KAI
Prior knowledge	About prior knowledge
EQF	About the European Qualification Framework
Elements	
Presentations	Creating effective presentations
Knowledge clips	How to created effective knowledge clips
Asking questions	About asking questions

Instructional text	How to write effective instructional texts
Self-assessment	How to create a self-assessment with an answer model
Lab sessions	Designing laboratory sessions
Overarching topics	
Visuals	Powerful visuals for (technical) learning
Intellectual property	How to respect intellectual property?
AI as teaching assistant	How to integrate AI as a teaching assistant?
Bloom's revised taxonomy	About Bloom's revised taxonomy
Working model	How to write a working model
Multimedia principles	Multimedia principles for effective learning
Especially for courses	
Microcredentials	How to comply with the requirements for microcredentials and badges.

4.2 Workshops on e.g. digital tools for teachers, engineers and technicians

From October '24 a series of online interactive workshops were organised. The overview of the all the workshops can be found in Table 9.

- Each workshop was focussed on a specific topic. There were workshops related to specific elements, such as making instructional videos where also tools to design videos were explained. There were also workshops on digital tools such as genially or think link. There were also discussing-ongoing-work workshops with feedback on current work on the BBs. Here BB-developers could present their work so far, discuss it and received feedback. The topics were selected based on anticipated or experienced difficult aspects in designing learning materials or in exemplifying powerful tools.
- The workshops were recorded for the benefit of those unable to attend in person, thus ensuring that the content was available to a wider audience. All project members were able to access all presentations, additional materials and recordings via a team site, the same one as where the quality guidelines could be found. In addition, the recordings of the workshops on tools showed live demonstrations of the tool and functioned as a tutorial for users.

Table 9: Overview of Workshops During the Year

Title of the workshop	Category
Teaching and learning and its relation	Overall
Building knowledge clips	Element Digital tools for teachers
Developing material with genially	Digital tool for teachers
Making instructional video's	Element Digital tools for teachers
Instructional design for online education	Digital tools for teachers
Simulation and online calculation tools	Digital tools for engineers and technicians
Thinklink: creating immersive learning content	Digital tools for teachers
Writing an instructional text	Element
Jupyter notebook (cancelled due to illness)	Digital tools for engineers and technicians
How to use AI during developing your BB?	Overall Digital tools for teachers
Workshop on lab sessions	Element Overall
Feedback on current work of BBs (6 times)	Overall

Also during every general meeting the educational team organised several workshops to gradually involve BB-developers and course designers into the requirements and to equipe them with the essential information and skills to develop their BBs or courses. In Table 10 an overview of these workshops can be found. The workshops during the online general meetings were recorded.

Table 10: Overview of the Workshops During the General Meetings

Title	Category
GM1: Genk Thor	
AI for education	Overall Digital tools for teachers
Quality guidelines, ULO's and BBs	Overall
General Meeting 2 Online	
Explanation of the quality guidelines based on a developed BB. (twice)	overall
Lessons learned from the reviews	Overall
General meeting 3 Arnhem	
Process of developing and using BBs	Overall
Hands on workshop Gen AI	Overall Digital tools for teachers
Lessons learned of the BB reviews, and Quality guidelines for P4ELECS courses	Overall
General meeting 4 online (to come 30/3 – ¼)	
Onboarding (new) authors	Overall
How to integrate BBs in our curricula	Overall

4.3 Coaching by EDU-experts

During the first half of the project, each BB developer could approach the educational team for individualised assistance. Should any individual they have an enquiry, they were invited to contact the educational team (e.g., on ways to formulate the learning outcomes and prior knowledge or on the formulation of the self-assessment). These conversations helped them structure their work and guided them in the desired direction, enabling them to save time. Also questions concerning the development of courses were welcomed.

To facilitate fast responses to questions, a shared agenda was employed. On a weekly basis, each member of the educational team allocated time in their schedule for a meeting. In this way, questions could be discussed within the same week (see Figure 5 for an example).

Figure 5: Example of the Shared Agenda to Ease the Organisation of Contact

4.4 Reviews of the BBs by the educational team

To support BB-developers in their work with their BBs the educational team organised reviews. A review template was developed for these reviews (see Annex 4). This template mirrored the quality criteria for BBs, the same three tables of the quality criteria formed the backbone of the document (see Figure 6 for an example). For each BB and element of the BB all criteria were assessed.

Figure 6: Screenshot of the Educational Review Template on Self-Assessment

	+/-/?
1. The self-assessment **covers all the learning outcomes of the BB.**	
2. The learners can do the self-assessment **based on** the topics covered in the different elements of **the BB** and the information provided in the assessment.	
3. All questions are **formulated clearly**.	
4. The **conditions** under which the learner should answer the self-assessment are clearly described.	
5. It is possible for the learner to **self-assess the correctness** of the answer, with the information provided.	
6. It is possible for the learner to **self-assess the overall quality** of the answers.	

At the start of the reviews, the BB-developers gave the reviewers access to their BB which they then reviewed. This was followed by an online meeting to discuss the findings and suggestions for changes were discussed. This conversation was felt necessary to make sure that the feedback was well perceived as an aid for improvement.

Later on, when experience with developing BB was gained, only written feedback was given. When felt necessary or when preferred, a meeting was planned. Some authors booked a meeting for each of their BBs.

4.5 GenAI assistant

During the project we built a GenAI assistant to support the experienced and new BB-developers in the development of their BB and to facilitate the educational review process.

- Some BB-developers only write one or two BBs and often new team members are added. They need a quick way to get acquainted with the education criteria and support available. The GenAI assistant could be a first-aid help for BB-developers.
- The review process is time-consuming (at least 2h/BB) for the educational team and at the start the review was often confounded by the lack of essential information provided by the BB-developer. The GenAI assistant was therefore also designed to help BB-developers to know if all essential information was available. This helps that the reviewer can concentrate on educational issues.

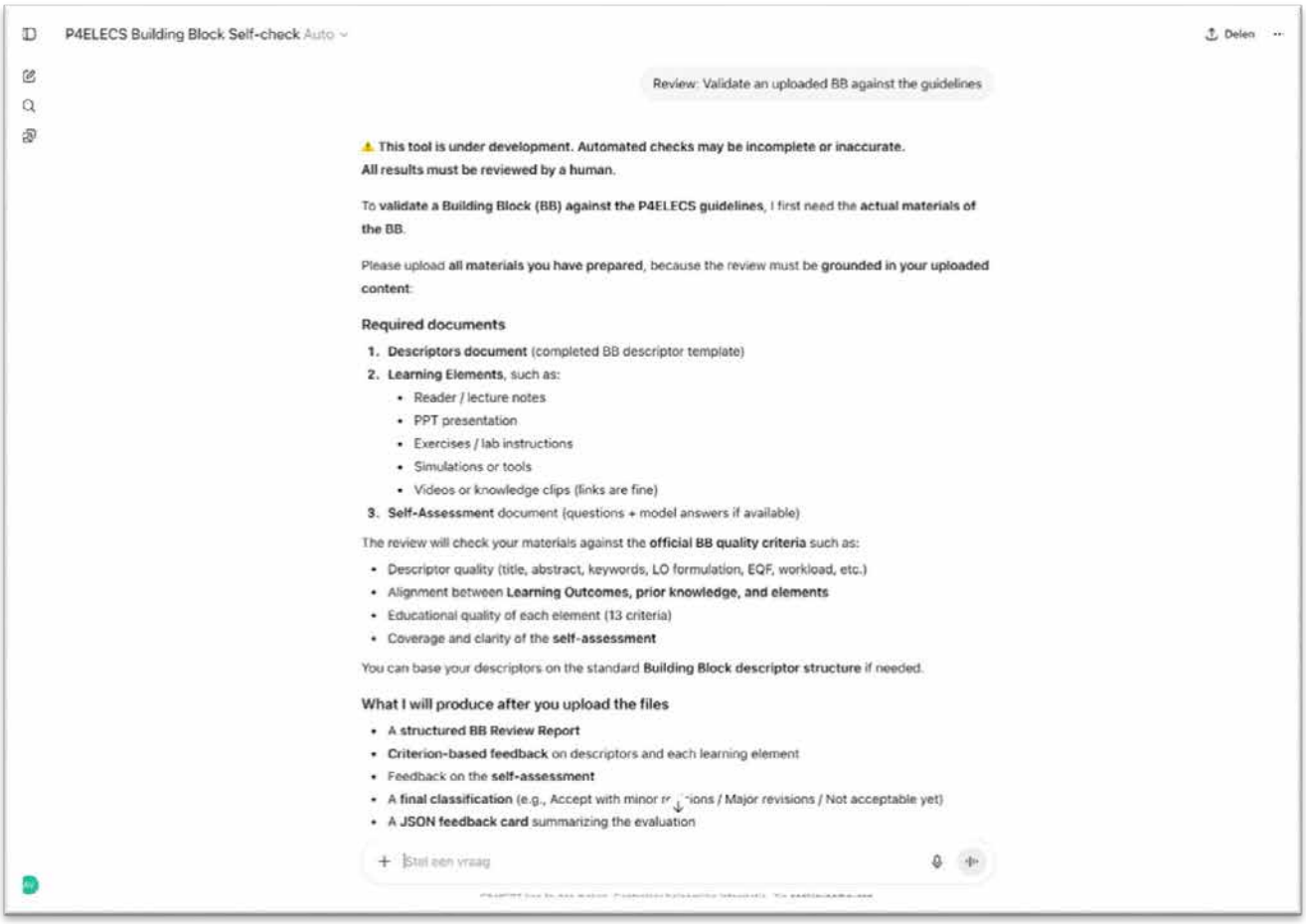
The GenAI assistant was not designed with the idea to eliminate human support or to do an educational review without human intervention. It is conceived as an assistant that will help to improve the process and raise the bar for the education quality of the material being developed.

The development of the BB/GenAI assistant directly builds on the vision, objectives, and implementation strategy described in the Application Form. During the proposal phase, extensive discussions were held on how to operationalise the BB methodology in a way that would be both scalable and sustainable, while maintaining educational quality. The assistant is a concrete outcome of these iterative design choices and translates the application's conceptual framework into an accessible, practical support tool.

From the outset, the assistant was conceived not merely as an evaluation instrument, but as a comprehensive design support tool for BB-developers. In addition to providing tailored feedback on uploaded BB drafts, the assistant is explicitly connected to all project-developed support materials, including guidelines, quicksheets, and quality criteria. This allows the assistant to go beyond compliance checking and to offer targeted, constructive feedback that actively helps designers strengthen their Building Blocks. Feedback is therefore not generic, but grounded in the agreed methodological framework of the project.

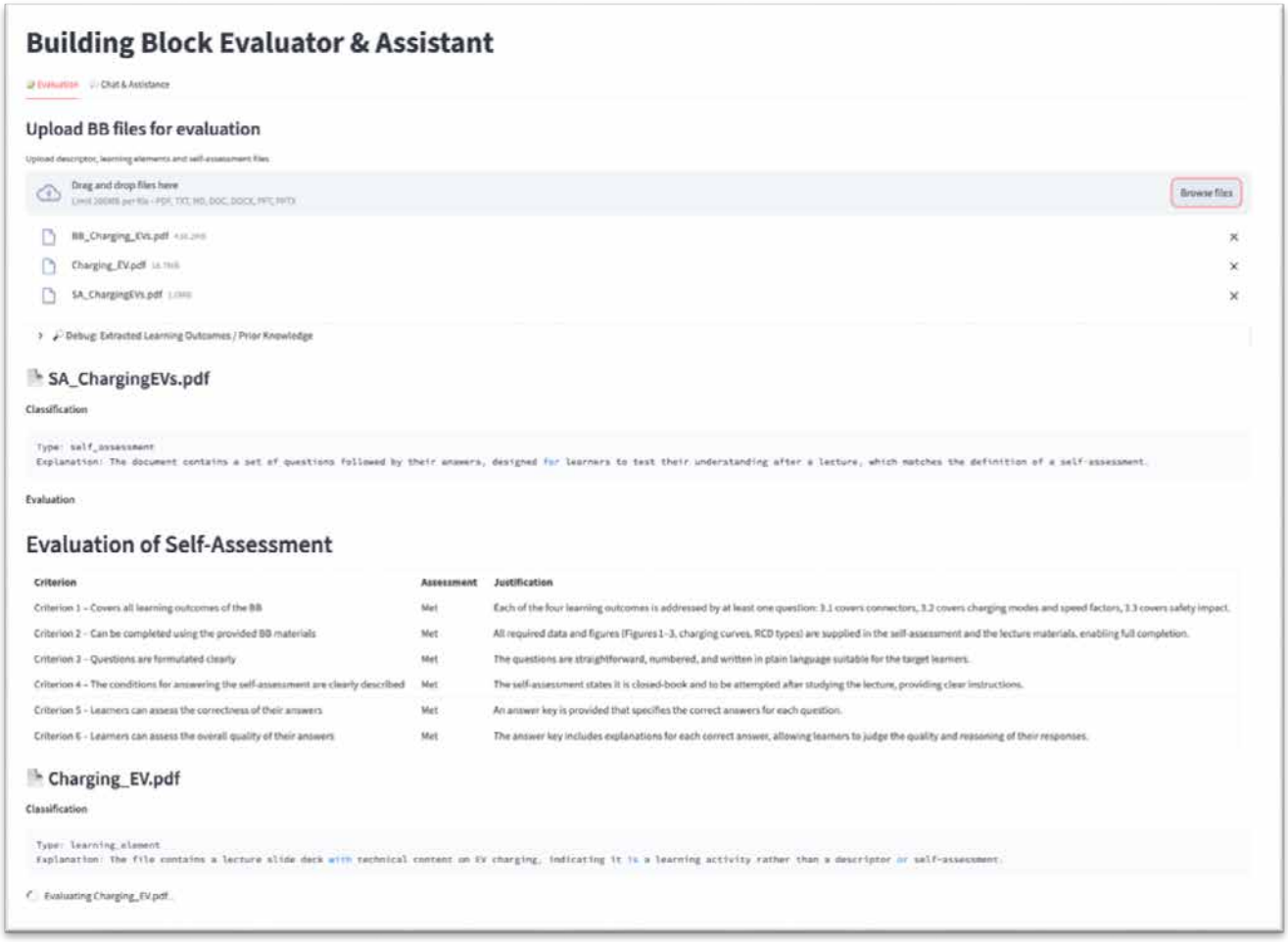
A key functional strength of the assistant lies in its dual role. On the one hand, it supports experienced designers by offering fast, structured feedback and by acting as a reflective partner during the design process. On the other hand, it provides significant added value for new designers entering the project at a later stage. Through guided interactions and direct references to the available support materials, new designers can independently design and refine Building Blocks without the need for the extensive training trajectories that were required for the first generation of BB designers. In this way, the assistant contributes directly to capacity building and lowers the threshold for onboarding new contributors.

Figure 7: Screenshot of the Custom Chat GPT



The development process itself was highly iterative and closely aligned with the ambitions set out in the Application Form. An initial custom GPT version was developed and tested during the General Meeting in Arnhem, where its potential was immediately recognised by project partners (see Figure 7 for an example of a conversation with this version). Based on their feedback and on practical constraints related to accessibility and institutional policies, a strategic decision was taken to further develop the assistant as a local solution (see Figure 8). This choice ensured that all support materials could be fully integrated and that the tool could be made available to all partners.

Figure 8: Screenshot of the Custom Building Block Evaluator & Assistant



Although the development of the GenAI assistant was not foreseen in the project, it was considered to have great potential in supporting BB-developers and reviewers. Therefore we engaged in developing it. It is important to emphasise that the current version of the assistant represents a first beta release. While the core functionalities are in place, the tool is still under active development and refinement. The development team encountered several challenges along the way, particularly in identifying the most appropriate instruction structures, selecting suitable language models, and designing an API architecture that supports the intended functional behaviour. These challenges led to multiple iterations and required continuous experimentation and adjustment. Despite encountering several obstacles, workable solutions were consistently found, resulting in a stable and functional beta version.

Detailed information on where to find the GenAI assistant is available on the BBP or can be requested by emailing to the authors of this deliverable.

4.6 Support for Designing Laboratory sessions

4.6.1 Designing High-Quality Laboratory Learning Experiences: Principles

One specific focus of the team was to provide guidelines for designing high-quality learning experiences in laboratory settings. Traditional, resource-intensive "cookbook" laboratory formats no longer align with contemporary insights into how students learn, nor with the infrastructural constraints faced by many institutions. As part of the P4ELECS workshop and the accompanying quicksheet on designing laboratory sessions (see 4.1 and 4.2), the educational team developed guidelines for a laboratory designing laboratory sessions informed by coherent instructional design principle, considering key elements such as learning outcomes, the learning environment, assessment strategies, and students' prior knowledge and experiences.

We began by addressing the question of **how to design effective and efficient laboratory learning experiences**. To explore this question, we mapped existing research on laboratory instruction and identified two key elements. The first is **functional alignment**, referring to the alignment between the major components that influence student learning through the explicit integration of instructional design frameworks. The second is **structural alignment**, which clarifies what students are expected to do across the three phases of laboratory sessions: **pre-laboratory, laboratory (contact hours), and post-laboratory**. Adopting this holistic approach addresses a key concern regarding the efficiency of laboratory sessions, as highlighted in the P4ELECS proposal, by enabling more effective use of contact hours, mitigating constraints associated with experimental setups, and improving accessibility for students. Given the rapid advances in and benefits of educational technologies, we also advocate for **blended laboratory delivery modes**, including hands-on, virtual, and remote formats when technological and infrastructural conditions permit. However, the selection and integration of these modes should be informed by their **distinct pedagogical affordances** and guided by instructional design frameworks that consider how learning outcomes, teaching and learning activities, and assessment interact.

Among the specific recommendations, the team encourages educators to move away from overly scripted "cookbook" procedures and instead create opportunities for students to **think, explore, and make decisions during experimentation**. Approaches such as **Predict–Observe–Explain (POE)** can support this shift by encouraging students to formulate predictions, compare them with observations, and explain discrepancies, thereby promoting deeper engagement with the learning process.

We implemented these guidelines in the context of a **smart grid laboratory** offered as part of the joint programme *Master in de Industriële Wetenschappen*, *afstudeerrichting energie*, jointly delivered by KU Leuven and Hasselt University. In particular, we transformed the traditional cookbook-style laboratory format, which relied heavily on detailed lab manuals, into a three-phase structure aimed at promoting deeper student learning. The details of the changes implemented, as well as students' reported experiences with the redesigned laboratory sessions, will be disseminated in a forthcoming conference or journal publication.

4.6.2 A conceptual study on laboratory instruction and quality guidelines

An important step in developing guidelines to support the design of laboratory activities was a research study aimed at exploring the literature and identifying comprehensive model to laboratory instruction and approaches to enhance student learning. This work was presented at the European Society for Engineering Education (SEFI) Conference in Tampere, Finland, in September 2025. The full paper is included in Annex 5. In what follows, we provide a brief overview of the study.

A key recommendation emerging from recent research is to view laboratory design through a holistic instructional framework. Laboratory learning should be structured across three interconnected phases: pre-laboratory, laboratory, and post-laboratory. Each phase serves a distinct pedagogical purpose.

Pre-laboratory activities activate students' prior knowledge and prepare them cognitively and affectively for the experiment, helping them understand the relevance and context of the experimental task. **Laboratory (in-lab) activities** enable students to actively engage in experimentation, inquiry, and decision-making while conducting experiments, collecting data, and interacting with laboratory equipment. **Post-laboratory activities** encourage students to reflect on both the process and the results of the experiment, connect their observations to theoretical concepts, and examine discrepancies or unexpected outcomes. This phase also provides an opportunity to assess the extent to which the intended learning outcomes have been achieved.

With thoughtful integration of different phases and modes of delivery, educators can increase flexibility, enable visualization of complex processes and phenomena, and reinforce conceptual understanding. Effective laboratory design therefore requires not only attention to the experimental setup but also deliberate consideration of how different learning environments, instructional strategies, and assessment practices work together to support student learning.

5. Lessons learned and recommendations

Reflecting on our experience in developing quality guidelines and collaborating with educators responsible for designing building blocks and courses, we identified several valuable lessons that shaped the team's trajectory and involvement in the process. These insights may also serve as useful reflection points for educators developing learning materials in the future.

For future BB-developers, P4ELECS course-designers or for those interested in using BBs of P4ELECs or set up a similar project, we developed some recommendations.

EDUCATIONAL GUIDANCE IS VALUABLE

The development of educational material and the design of courses are complex processes, while the time available to carry these activities is often limited. Many developers involved in this work do not have formal educational training and therefore have a limited educational vocabulary. This is very often compensated for by practical experience and eagerness to learn more about it when explained clearly. Given their limited time, BB developers and course designers guidance and support are helpful to become quickly acquainted with the specific expectation and to improve the educational quality and ultimately student learning.

EDUCATIONAL GUIDANCE AS A MIX OF AVAILABLE MATERIAL OR TOOLS AND PERSONAL CONTACT IS HIGHLY APPRECIATED AND EFFECTIVE

Available material is very helpful to communicate and to inform. Personal contact is indispensable to express appreciation of current work and to motivate to do the extra mile.

In the timing of the P4ELECS project many activities took place simultaneously. The BBP was being developed while the first BBs were already being written, and at the same time quality guidelines for these BBs were still under development. The strength of this approach was a highly adaptive project environment. A disadvantage for BB developers and course designers was that not all rules and procedures were clear from the outset. Even though the basic structures remained consistent, these ongoing adaptations required additional effort from BB developers and course designers. The human contact was a stimulus for continuous work. A quick call can solve or anticipate many problems and save a lot of time.

ISSUING A MICROCREDENTIAL AND ACCEPTANCE OF A MICROCREDENTIAL ARE TWO DIFFERENT THINGS

In the project we wanted to design internationally accepted microcredentials. However, it became clear that it was possible to guarantee that a course complies with the requirements for a microcredential without guarantee that it will be accepted everywhere. The landscape for microcredentials is still evolving (e.g. European Commission, 2025). Although evolutions are promising, not everything is already in place nor fully set up.

Therefore it is interesting to follow up promising initiatives such as

- National initiatives concerning microcredentials, where institutions agree on specific criteria and mutual recognition. Think for example of NPULSE in the Netherlands or microcreds in Ireland.
- Tools that support the recognition of microcredentials, such as the micro-evaluator.

THE USABILITY OF THE BBS FOR THE VETS

Educational guidance for VET and HEI students differs as prototypical students and the intended learning outcomes differ. VET student need extra or other educational elements in the learning material and more hands-on sessions (lab) as the learning outcomes are more practically oriented.

The concept of BBs seems of added value for the teachers of EQF 5 but not directly to the students. Initiatives where train the trainer modules are being developed in addition to the students learning material seems promising. It might be that an extension of the list of elements, with for example a teacher manual, would be valuable, as well as train the trainer courses.

AN ULO MATCH MAKER BASED ON AI

During the project for each spider a set of unit of learning outcomes (ULOs) were developed (see deliverable 2.2). The ULOs are identification of the knowledge, skills, attitudes, competences, … that different types of professionals will need in the future, formulated as learning outcomes.

Currently there is only an implicit link between the BBs and the ULO, although a more explicit link would be relevant for different parties.

1. For teachers, program developers, professional organizations, learners it is helpful to select relevant BBs
2. For spider coordinators it is helpful to know what additional BBs should be developed and – in the future- what BBs might have become superficial.

Therefore, it would be valuable to develop a tool, such as a “ULO matchmaker, that periodically provides for each spider, an overview of the available BBs that are relevant for each ULO.

6. Literature

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Annexes

Annex 1: Educational Quality Criteria for Building Blocks

Annex 2: Educational Quality Criteria for P4ELECS Courses

Annex 3: Quick sheets

Annex 4: Feedback Template Educational Quality Criteria for building blocks

Annex 5: Conference paper 'Designing Laboratory Sessions in Science and Engineering'