P4ELECS
Platform for Electrification Skills & Competences

Quicksheet

How to set up learning outcomes (and CDIO/KAI)

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About

- Learning outcomes describe **what a person should be able to do after successfully completing this Building Block (BB)**. They state the expected outcomes of the learning or development that took place.

- Well-defined learning outcomes are valuable as they **inform individuals about the skills, knowledge and competencies they will develop**. Learning outcomes help people decide if a particular building block is valuable for their needs or goals.

- Describing learning outcomes is important because **it gives direction to the development of your building block**. When setting goals for your building block, using a "backwards design" approach is effective: start with the end in mind and build back from there (Grose-Fifer et al., 2019). The end represents the competencies you want your students to master or the results you want to achieve. This approach ensures that activities build up logically and coherently toward your desired outcomes.

Benefits

For the BB-developer:

- Clarify exactly what you aim to achieve with your BB.
- Create a logical progression toward practical applications.
- Provide clear criteria for measuring success.
- Communicate expectations effectively to others (e.g., colleagues, stakeholders).
- Verify that your approach meets the set requirements.
- Balance knowledge, attitudes and implementation skills in the design.

For the learners:

- Select a BB that fits their needs and learning goals.
- Connect acquired knowledge to real-world applications.
- Maintain motivation through clear, achievable targets.
- Understand what is expected of them and how success will be measured.

Step-by-step creation guide

Identify purpose and level

Before formulating learning outcomes, **clarify the purpose, the intended level and the context**:

- What exactly do you want to achieve?
- What is the scope and relevance of the learning outcome?
- What is the learner's current level of knowledge or expertise?
- How does this learning outcome fit within broader (learning) goals or personal/professional development?
- Which phases of the process (conceive, design, implement, operate) are emphasized?

Check alignment with CDIO and KAI

When developing learning outcomes, it is crucial to ensure alignment with established frameworks such as CDIO and KAI.
The **CDIO framework** (Conceive, Design, Implement, Operate) structures the educational process around the full lifecycle of developing and using products, systems or solutions.

- **Conceive**: students are encouraged to identify needs, define problems and develop conceptual approaches.
- **Design**: involves developing detailed plans or models
- **Implement**: focuses on building, testing or deploying the solution.
- **Operate**: centers on using and maintaining the result in its intended context.

Alongside CDIO, the **KAI model** distinguishes between:

- **Knowledge**: encompasses theoretical understanding, such as concepts, facts and principles.
- **Attitudes**: include values, motivation and willingness to act.
- **Implementation**: refers to the ability to apply knowledge and skills in real or simulated practice.

In practice, many learning outcomes naturally align with one or more of these stages and domains.
For example:

- attitude-oriented outcomes
  - often most visible in the early CDIO stages
  - where students demonstrate open-mindedness, ethical awareness or collaboration during problem definition and planning.
- Implementation outcomes
  - closely tied to the later CDIO stages,
  - actually building, testing, or operating something in practice.
- Knowledge
  - woven throughout but is especially present when conceptualizing and designing solutions.

! Rather than aiming to cover every stage or domain in every outcome:

- Focus on the specific purpose and main emphasis of your outcome.
- Consider what is already present in your course or module.
- Deliberately choose the phase and domain that adds the most value or focus for the learner.

Formulate specific and measurable learning outcomes

Focus the learning outcome on what the student will be able to do afterwards, not on the learning activities.

- Less effective: The student will read about electric circuits.
- Better: The student can describe the function of an electric circuit and provide two practical examples.

Use clear, observable action verbs (see, for example, Bloom's taxonomy).
Avoid vague verbs like "understand" or "know";
→ instead, use verbs such as "explain," "demonstrate," "create," "analyze," or "evaluate."
Use **one observable action verb** per outcome.

Structure each outcome as:
Subject + action verb + object (+ context/criteria)

- Example: The student can analyze the energy efficiency of a PV trailer based on given design parameters.

Specify the context and any relevant parameters or standards, if appropriate.

Examples of less effective and improved learning ouctomes

Learning outcomes are only valuable when they are **concrete, clear and actionable** for both teachers and students.

- **Be specific, not vague**
  - Vague formulations such as:
    - "*The student understands different energy sources*"...does not indicate what the student should be able to demonstrate or produce.
  - A much stronger outcome would describe observable actions and specific criteria, for example:
    - "*The student can compare types of energy sources, such as solar, wind and fossil fuels, and summarize their main advantages and disadvantages.*"
  - This shifts the focus from internal processes to measurable performance.

- **Avoid describing activities**
  - Another common pitfall is to formulate outcomes that merely describe activities:
    - "*The student will work on circuit analysis problems*". This does not show what the student should achieve.
  - An improved version would specify:
    - "*The student can analyze an electrical circuit and calculate the current using Ohm's law.*"
  - This approach makes assessment straightforward and the goal unambiguous.

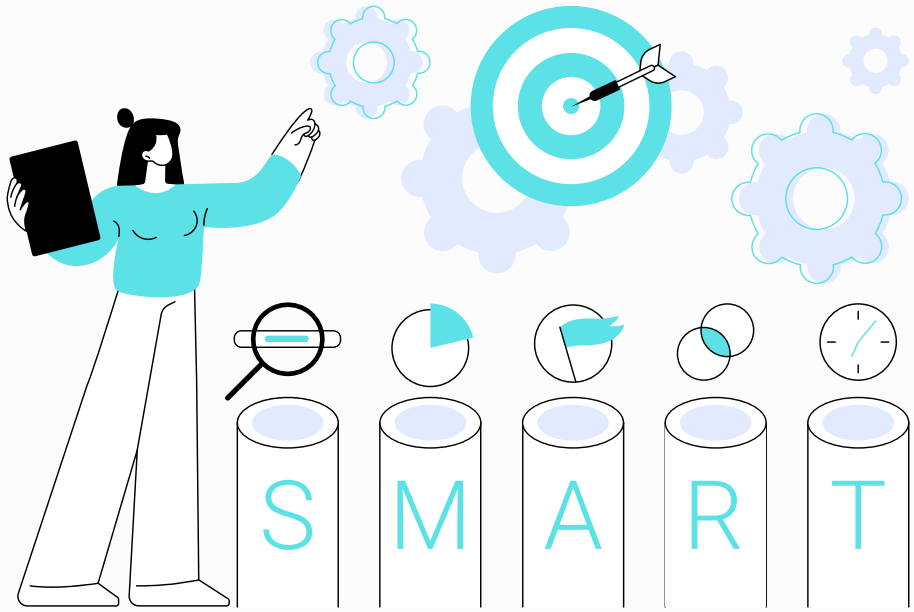
- **Clarify soft skills and attitudes**
  - When it comes to attitudes or soft skills, avoid verbs that cannot be objectively measured, such as:
    - "*The student values teamwork*"...this does not clearly show what the student does.
  - A better alternative focuses on behaviour that demonstrates the attitude, for example:
    - "The student can collaborate effectively by contributing constructively to a group project and providing feedback to peers."
  - This makes the intended learning outcome observable and assessable.

- **Be precise with practical skills**
  - Practical skills are best described through clear actions and expected standards.
    - Vague example: "*The student knows how to use measurement equipment*"...does not specify what correct use looks like.
    - A more precise formulation would be: "*The student can use a multimeter to measure voltage, current and resistance in a given circuit, following laboratory safety guidelines.*"
  - This provides clarity on both the action and the expected quality of performance.

Apply SMART criteria

Each learning outcome should be:

- **Specific**: Clearly states what will be accomplished.
- **Measurable**: Includes criteria for determining achievement.
- **Achievable**: Realistic given available resources and constraints.
- **Relevant**: Aligns with broader goals and needs.
- **Time-bound**: Includes a timeframe for completion.



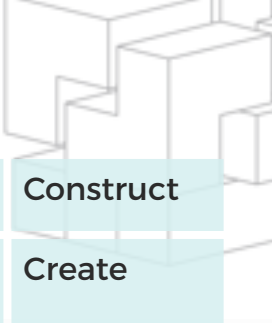
Tips

- Develop a **short, powerful list.**
- **Rule of thumb**: limit the list to maximum 6 learning outcomes.
  - If you have more, consider giving 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 consider dividing it into different BBs.

Action verbs

The table below provides a comprehensive list of action verbs organized according to Bloom's Taxonomy of cognitive processes. These verbs can help you formulate precise learning outcomes that clearly indicate the level of cognitive engagement required. *To gain a better understanding of Bloom's Taxonomy, take a look at the quicksheet 'About the taxonomy of Bloom'.*

Remember	Understand	Apply	Analyze	Evaluate	Create
Choose	Classify	Apply	Analyze	Agree	Adapt
Define	Compare	Build	Assume	Appraise	Build
Find	Contrast	Choose	Categorize	Assess	Change
How	Demonstrate	Construct	Classify	Award	Choose
Label	Explain	Develop	Compare	Choose	Combine to smth new
List	Extend	Experiment with	Conclusion	Compare (and evaluate	Compile



Name	Infer	Interview	Discover	Criteria	Construct
Omit	Interpret	Make use of	Dissect	Criticize	Create
Recall	Outline	Model	Distinguish	Decide	Delete
Relate	Relate	Organize	Divide	Deduct	Design
Select	Rephrase	Plan	Examine	Defend	Develop
Show	Show	Select	Function	Determine	Discuss
Spell	Summarize	Solve	Inference	Disprove	Elaborate
Tell	Translate	Utilize	Inspect	Estimate	Estimate
			List	Evaluate	Formulate
			Motive	Explain	Happen
			Relationships	Importance	Imagine
			Simplify	Influence	Improve
			Survey	Judge	Invent
			Take part in	Justify	Make up
			Test for	Mark	Maximize
			Theme	Measure	Minimize
				Opinion	Modify
				Perceive	Original

Useful sources

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