ETH zürich

Mapping Learning & Using Rubrics to Align Learning Outcomes to Instruction and Assessment

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ETH Zurich
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Outline

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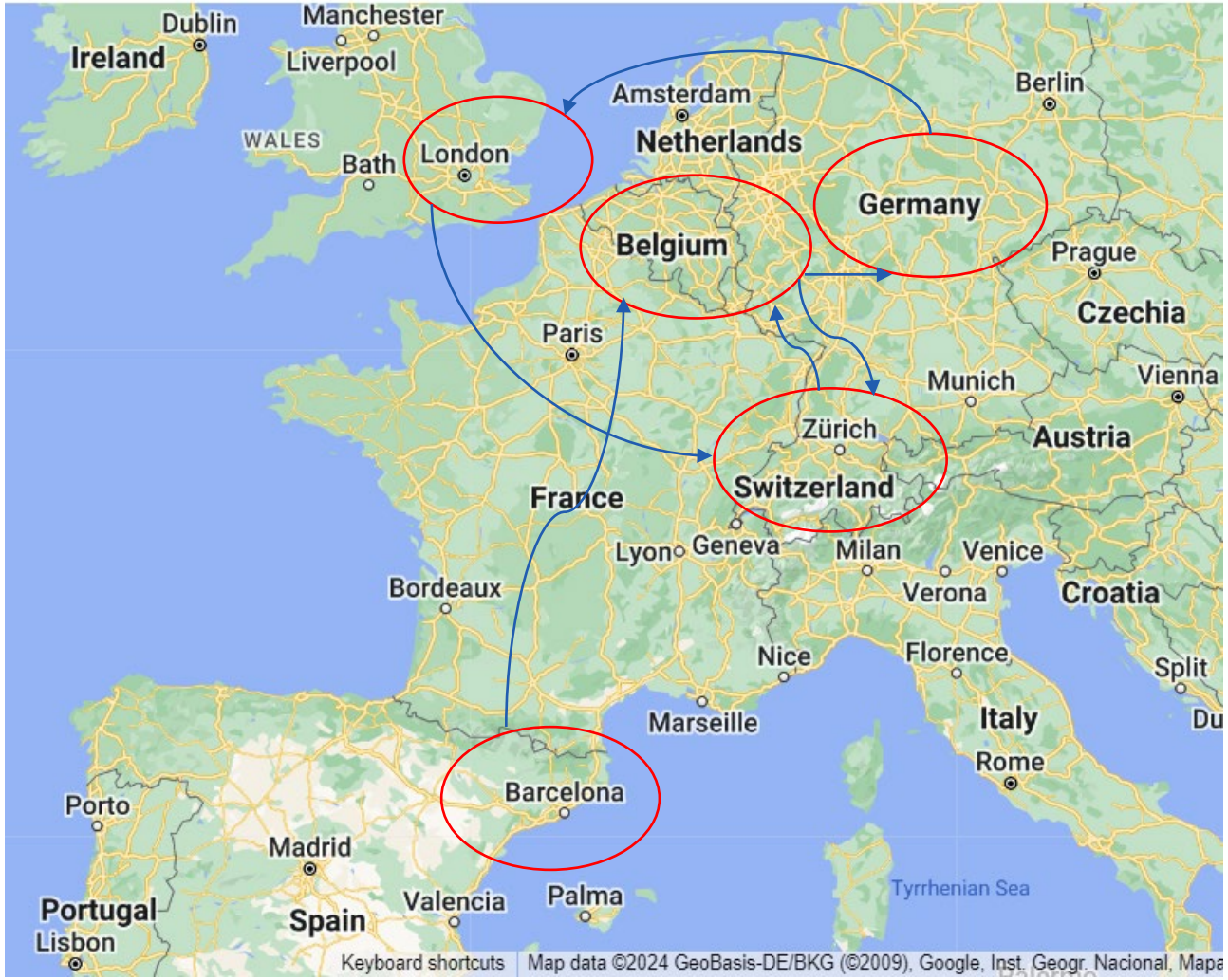
Where do I come from?

Google maps

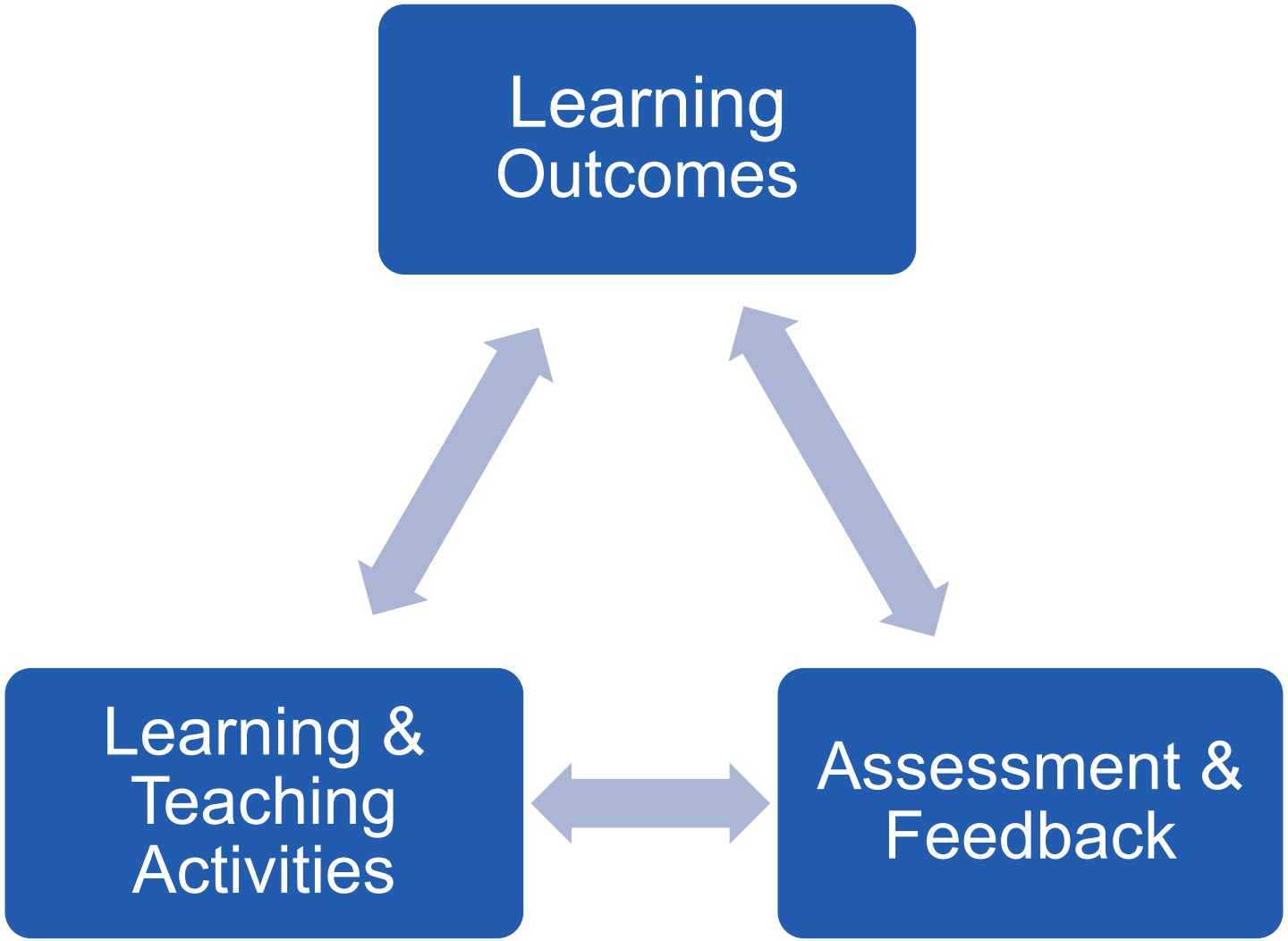
Where do I come from?

From engineering graduate to education specialist



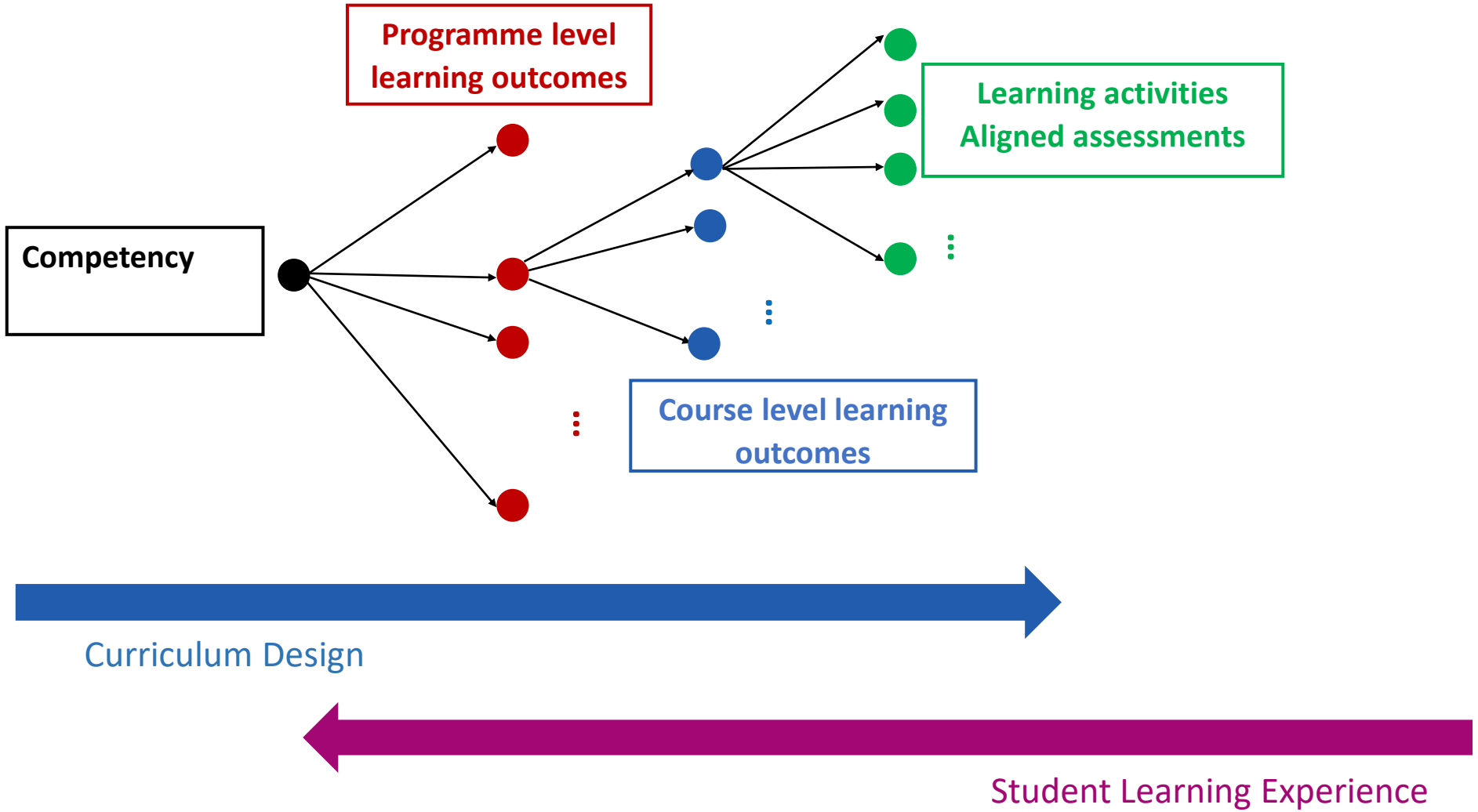
- Tarragona-Barcelona, Spain
  - Learning outcomes
  - Curriculum Design
  - Science Education: concepts, skills, attitudes
  - PISA: competencies
- Brussels, Belgium
  - Education for Sustainable Development
  - Faculty development
- London, United Kingdom
  - Curriculum Reform
  - Performance-based assessments
  - Rubrics
- Zurich, Switzerland
  - New degree: BSc/MSc Interdisciplinary Engineering

Constructive Alignment



Biggs, 1996

Alignment by design



Curriculum design vs. Curriculum revision

Curriculum design

- Program level & course level
- Curriculum designers or academics
- Instructors may not be involved in teaching
- No students

Example 1

New interdisciplinary engineering program at ETH Zurich

Curriculum revision

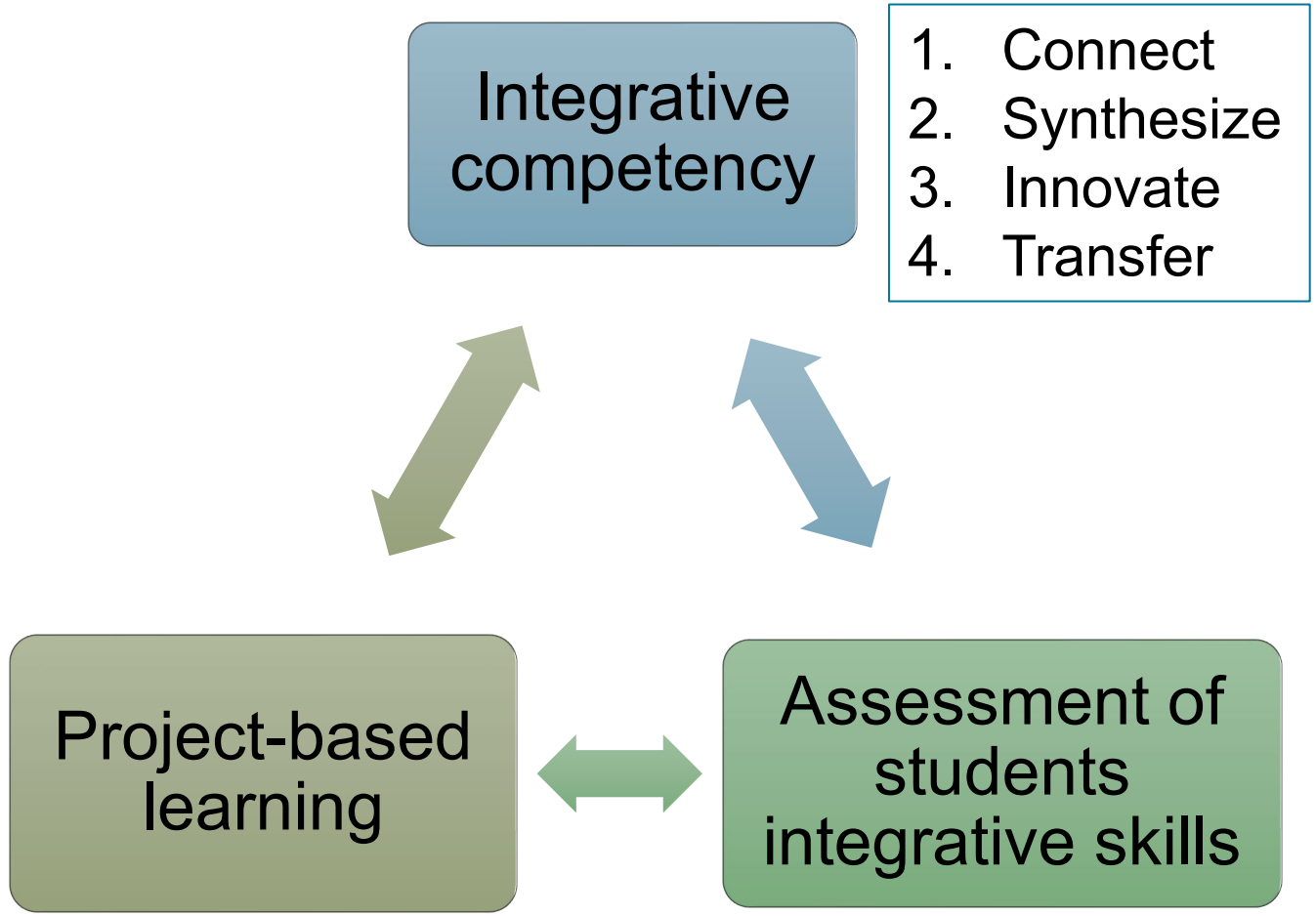
- Course level or program level
- Curriculum designers
- Instructors directly involved in teaching
- Students

Example 2

Revision of the MSc in Environmental Technology at Imperial College London

Example 1: Interdisciplinary Engineering Curriculum at ETH Zurich

Interdisciplinary learning = Integrative learning



How to achieve alignment in curriculum design?

- Project-based learning (PBL)
  - Program level
  - Standalone course
  - Course component
  - Shared by more than one course

- Integrative activities and assessments
  - Capstone projects
  - Grand challenges
  - Bachelor/Master's thesis
  - Internship if assessed

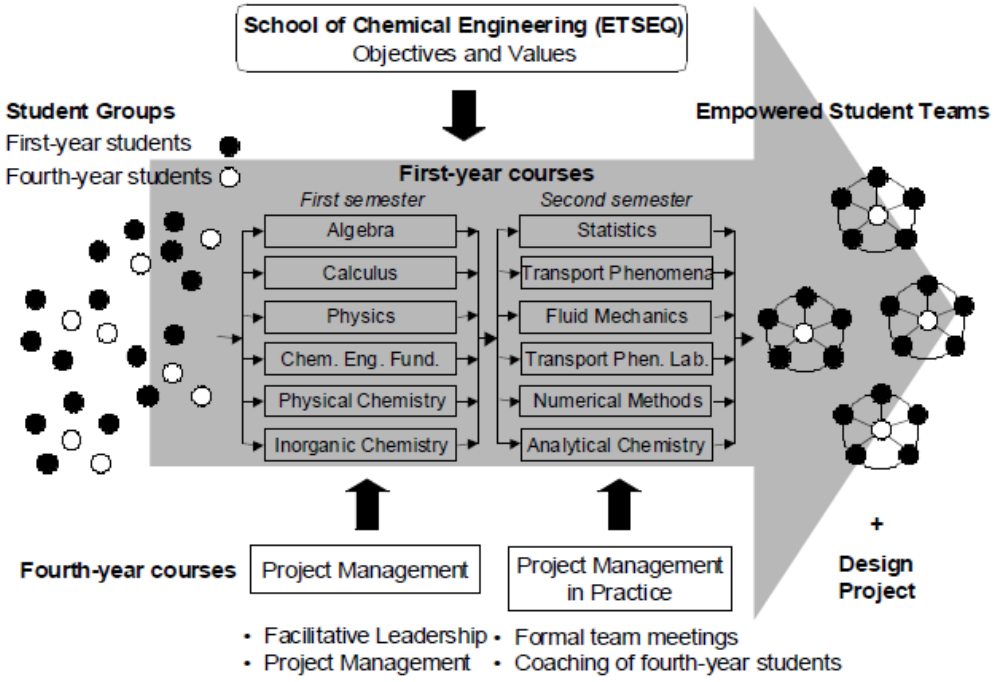
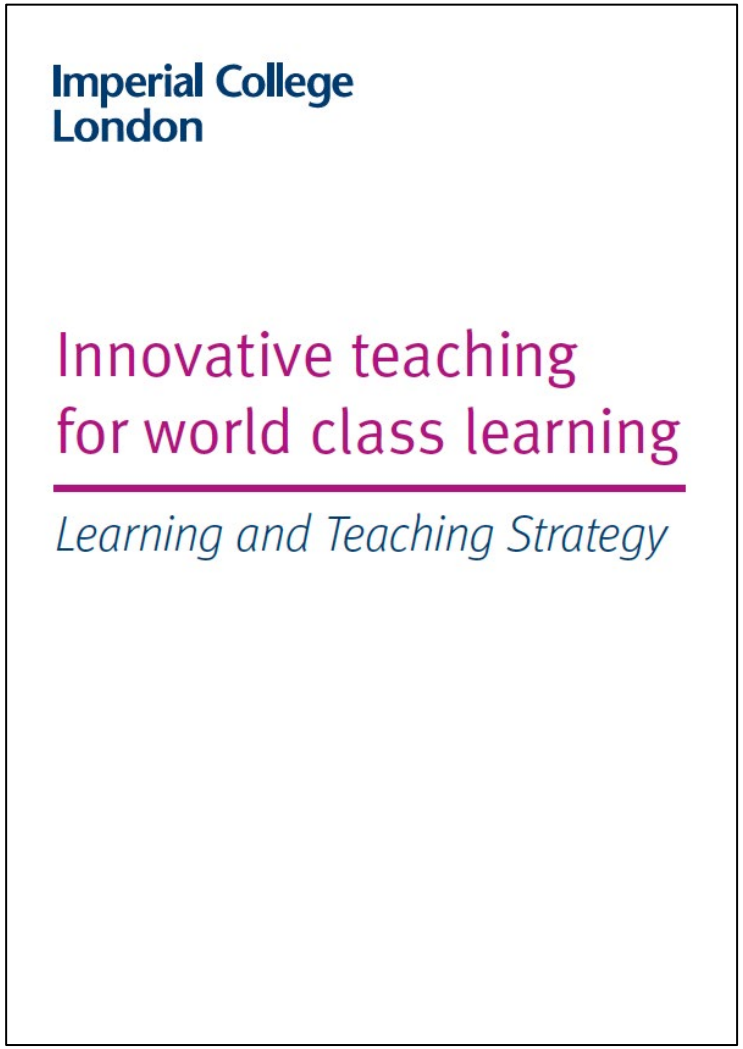


FIGURE 1

THE PROJECT-BASED COOPERATIVE LEARNING APPROACH AS DEPLOYED AT THE FIRST AND FOURTH ACADEMIC YEARS OF THE CHEMICAL ENGINEERING CURRICULUM AT THE ETSEQ.

Example 2: Curriculum revision at Imperial College London

- Learning & Teaching Strategy (2017-)
  - All programs, all levels
  - Graduate Attributes
  - Modular architecture
  - Module specification templates
  - Program specification templates
  - Website: documentation, guidelines
  - Training workshops



MSc in Environmental Technology: Modular architecture

Common courses

- 3 modules automun term
- 1 transversal module through 2 terms

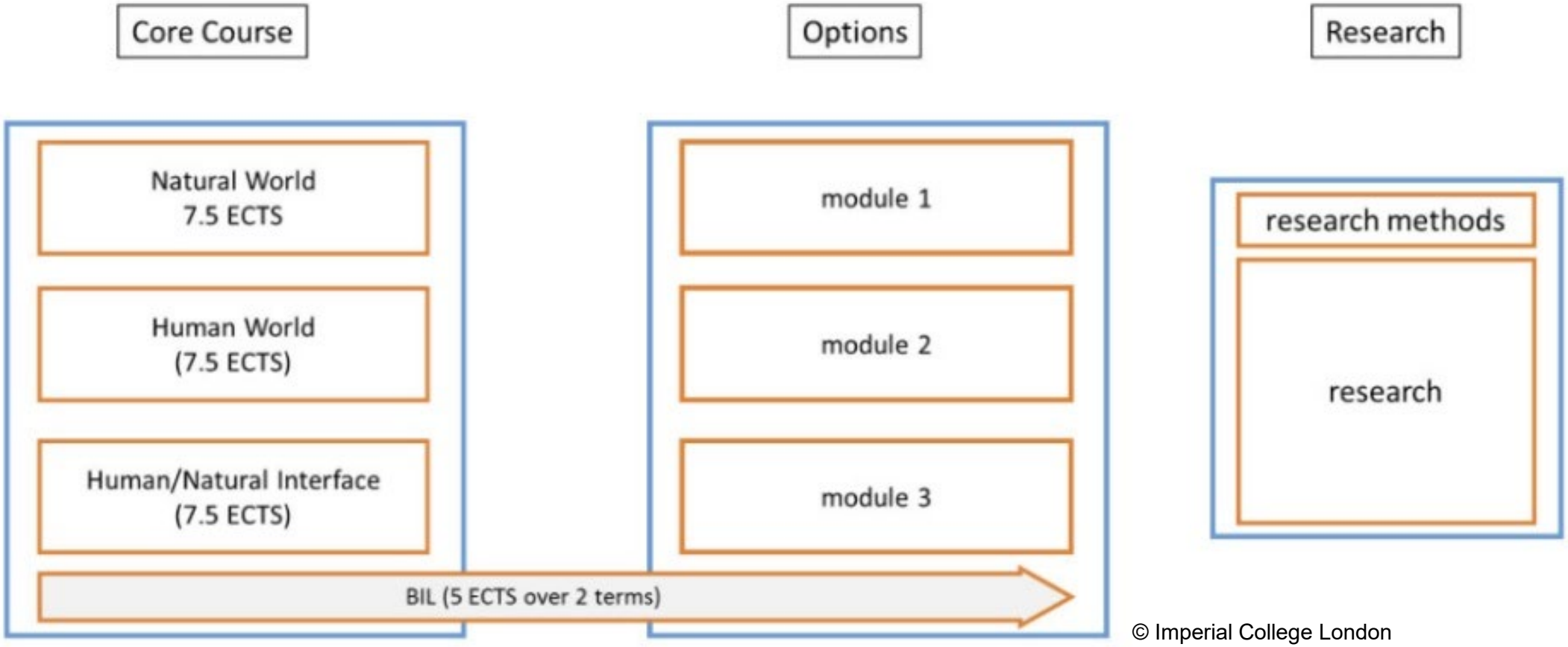
Options (specialties): spring term

- 1 out of 8 options
- 3 modules per option
- Contact:
  - 1-2 option convenors
  - 1-2 module leaders

Thesis: summer term

- Independent Research Project
- 1 module on research methods

MSc in Environmental Technology: Modular architecture



3 core modules + 3x8 option modules + 1 transversal + 1 research methods = 29 modules + 1 program template

Program level LOs mapped to Dublin descriptors

Descriptor	Intended Learning Outcomes (10) *On completion of the MSc you will be able to…*
Knowledge and understanding	1. demonstrate a broad understanding of sustainability from a range of perspectives 2. read and understand a broad range of appropriate literature 3. understand a range of analytical research methods, both theoretically and practically
Application of knowledge and understanding	4. critically select from and use a range of problem solving strategies to tackle complex and unfamiliar ill-structured problems in a self-directed manner
Making judgements	5. critically gather, analyse, synthesise and evaluate information 6. develop creative solutions and draw out original insights to sustainability problems 7. take responsibility for decisions that you make, taking into account the trade-offs and ethical considerations inherent in decision-making
Communication skills	8. communicate effectively to a range of audiences using a variety of media
Learning skills	9. use and be proficient in a range of transferrable and professional skills 10. demonstrate high personal self-efficacy and take responsibility for your own learning

Programme level learning outcomes

On completion of the MSc Environmental Technology programme you will be able to:

1. **Demonstrate** a broad **understanding** of sustainability from a range of perspectives relevant to environmental technology
2. **Critically engage** with a broad range of appropriate literature
3. **Critically engage with a range of quantitative and qualitative research methods**
4. **Critically select** from and use a range of problem-solving strategies and tools to tackle complex and unfamiliar ill-structured problems in a self-directed manner
5. Gather, **analyse, synthesise and critically evaluate** appropriate information relevant to environmental technology and sustainability
6. Critically **assess evidence of impact** from current sustainability policy and practice, and anticipate future risks in the context of evolving sustainability challenges
7. **Draw out original insights** and develop creative solutions to sustainability problems
8. **Take responsibility for decision making**, taking into account the trade-offs and ethical considerations inherent in decision-making
9. **Communicate** effectively to a range of audiences using a variety of media
10. **Manage your own development** in a range of appropriate transferable and professional skills
11. **Take responsibility for your own learning** and develop confidence in your own abilities to tackle complex sustainability challenges.

Module LOs aligned with program LOs

Core Course	Module title	Abbreviation	Module LOs
CC	The Human World	**HW**	1. Understand and critically apply the principles underpinning the social and policy dimensions of environmental change and management **(1, 2)** 2. Critically engage with and analyse the legitimacy of different knowledge claims and stakeholder perspectives **(4)** 3. Critically analyse, synthesise and evaluate knowledge relating to environmental governance and management **(5)**; 4. Identify trade-offs in problem solutions and understand how to mitigate them **(7; 8)** 5. Work effectively individually and in groups to develop creative solutions to contemporary sustainability problems **(11, 7)**
	The Natural World	**NW**	1. Demonstrate a critical understanding of sustainability from a range of perspectives relevant to environmental technology **(1, 2, 3, 6, 7)** 2. Infer and assess the impact of human/environment interactions **(6)**; 3. Critically analyse, synthesise and evaluate the breadth of pollution and natural resource-based sustainability issues **(1, 2, 5)**; 4. Critically apply simple statistical concepts and quantitative skills for evaluating uncertainty **(3, 6)**; 5. Effectively work individually and in groups to research, deliver and communicate high quality outputs using a range of media **(9)**
	The Human/Environment Interface	**HNI**	1. Critically analyse the legitimacy of different knowledge claims and understand how they may be effectively combined to tackle sustanability problems **(4)** 2. Infer and assess the impact of human-environment interactions **(6)**; 3. Identify trade-offs in problem solutions and understand how to mitigate them **(5, 8)** 4. Work effectively individually and in groups to develop creative solutions to contemporary sustainabilty problems **(11, 7)**

Mapping module LOs to program LOs

Programme LOs	Module LOs
PLO9. communicate effectively to a range of audiences using a variety of media	**Core Course Module 2 (CC2)** CC2LO5. Effectively work individually and in groups to research, deliver and **communicate high quality outputs** using a range of media **(9)**
	Option "Energy Policy" Module 1 (EP1) EP1LO7. produce clear, **critical and authoritative reports**, both on technical subjects and on policy issues. EP1LO8. confidently **present results orally**, at a level appropriate to their audience **(9)**.
PLO6. critically assess evidence of impact from current sustainability policy and practice, and anticipate future risks in the context of evolving sustainability challenges	**Core Course Module 2 (CC2)** CC2LO2. Infer and **assess the impact of human/environment interactions (6)**
	Core Course Module 3 (CC3) CC3LO2. Infer and assess the impact of human-environment interactions **(6)**
	Option "Business&Environment" Module 1 (BE1) BE1LO2. infer the potential consequences of current business thinking and operations, critically assessing impacts against sustainability projections and standards **(6)**.

Mapping module LOs to program Los: a snapshot

Programme LOs	Modules Option 1			Modules Option 2			Modules Option 3			…			Modules Option 8		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
PLO1	x			x	x		x	x		x		x	x		x
PLO2		x								x			x		
PLO 3															
PLO 4			x				x				x			x	x
⋮															
		x													
PLO 10				x					x		x	x		x	
PLO 11			x			x		x			x				x

Module Specification Template

Learning and teaching
Module
description

Learning outcomes	
Module content	
Learning and Teaching Approach	
Assessment Strategy	
Feedback	
Reading list	

Learning Outcomes: *4-8 Intended Learning Outcomes.*

Module Content: *Set out the Indicative module content – they key areas covered by the module.*

Learning and Teaching Approach: *Set out how the module will be delivered and how the different learning and teaching activities will support the students.*

Assessment Strategy: *Set out how the module will be assessed (formatively and summatively) giving the types of assessment which are used and the frequency of the assessment. Link to the Intended Learning Outcomes.*

Feedback: *Explain the arrangements for returning marked work, that students may receive provisional marks first, and explain how feedback will be given to students from both summative and formative assessment.*

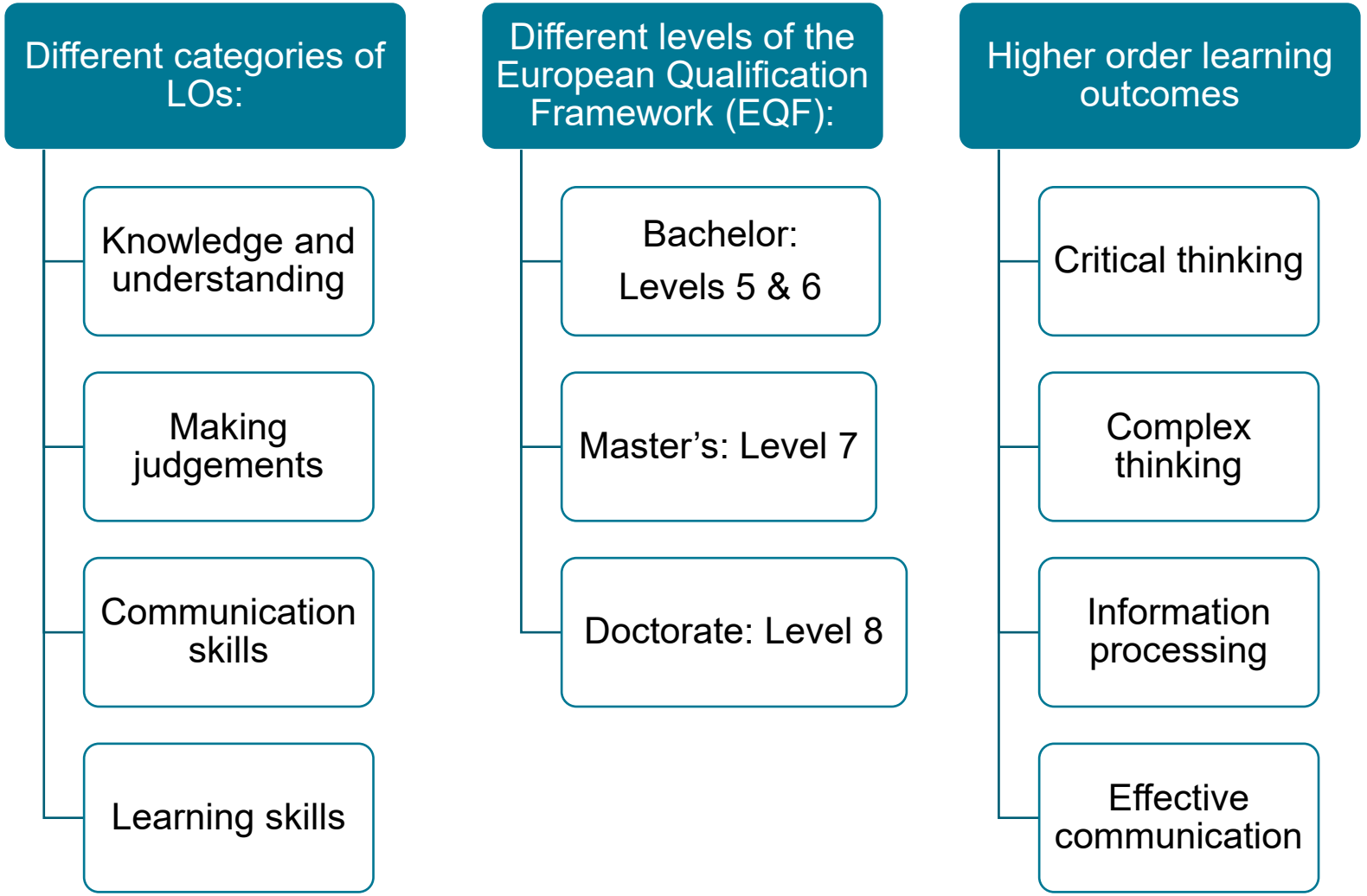
Reading list: *For further information on the Library's Leganto system, see:*
Leganto Reading Lists

Mapping assessments to LOs
Example: Option Energy Policy (EP)

Option	Module title	Abbreviation	LOs	Assessment	LOs covered
EP	Energy Technologies	**EP 1**	EP1LO1 EP1LO2 EP1LO3 EP1LO4 EP1LO5	Technology project: presentation	EP1LO1; EP1LO2; EP1LO3; EP1LO5
				Technology project: briefing note report	EP1LO1; EP1LO2; EP1LO3; EP1LO4
	Energy Economics and Policy	**EP 2**	EP2LO1 EP2LO2 EP2LO3 EP2LO4 EP2LO5 EP2LO6 EP2LO7	Group policy project: pitch presentation	EP2LO1; EP2LO2; EP2LO3
				Group policy project: viva presentation	EP2LO1; EP2LO2; EP2LO3; EP2LO4; EP2LO6; EP2LO7
				Group policy project: written report	EP2LO1; EP2LO2; EP2LO3; EP2LO4; EP2LO5; EP2LO6; EP2LO7
	Integrated Energy Systems	**EP 3**	EP3LO1 EP3LO2 EP3LO3 EP3LO4 EP3LO5	Multiple choice exam (20%)	EP3LO3
				Final exam (80%)	EP3LO1; EP3LO2; EP3LO3; EP3LO5

How to achieve alignment in curriculum revision?

LOs and assessments need to be adapted to



Authentic assessments

What are authentic assessments?

- Tasks that mimic real-world problems or situations faced by professionals
- Classroom activities that are rooted in community
- Students are active and independent learners
- Activities to be finalized/ planned/ executed with minimum intervention
- Students produce artefacts, portfolios, or reports
- Group or individual assignments

Assessment rubrics for authentic assessments

Analytic rubrics

Criteria	Performance level							
	1	2	3	4	5	6	7	8
C1	Descriptors				Descriptors			
C2	Descriptors				Descriptors			
C3	Descriptors				Descriptors			

Holistic rubrics

Criteria	Performance level							
	1	2	3	4	5	6	7	8
C1 Brief description	✓							
C2 Brief description				✓				
C3 Brief description								✓

How to develop analytic rubrics?

1

Break down LOs into various dimensions and define assessment criteria

2

Define a scoring system or rating scale to score criteria separately

Weigh the criteria

3

Formulate detailed descriptions for each criteria at each performance level

i.e. giving detailed feed on where the student is in their progression, what they need to work on

Drawbacks:

- More time to develop
- Criteria and performance levels to be well defined
- Training to ensure reliability when used by multiple graders

Performance levels

From Beginner to Expert

Performance level	Beginner	Novice	Competent	Proficient	Expert
Score (as a scale)	1	2	3	4	5

From Poor to Excellent

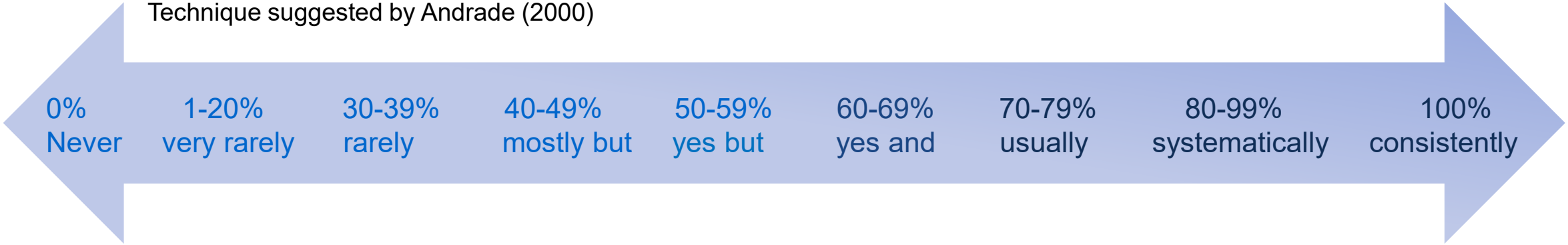
Performance level	Poor level	Intermediate	Good	Very good	Excellent
Score (as a %)	40	50	60	70	100

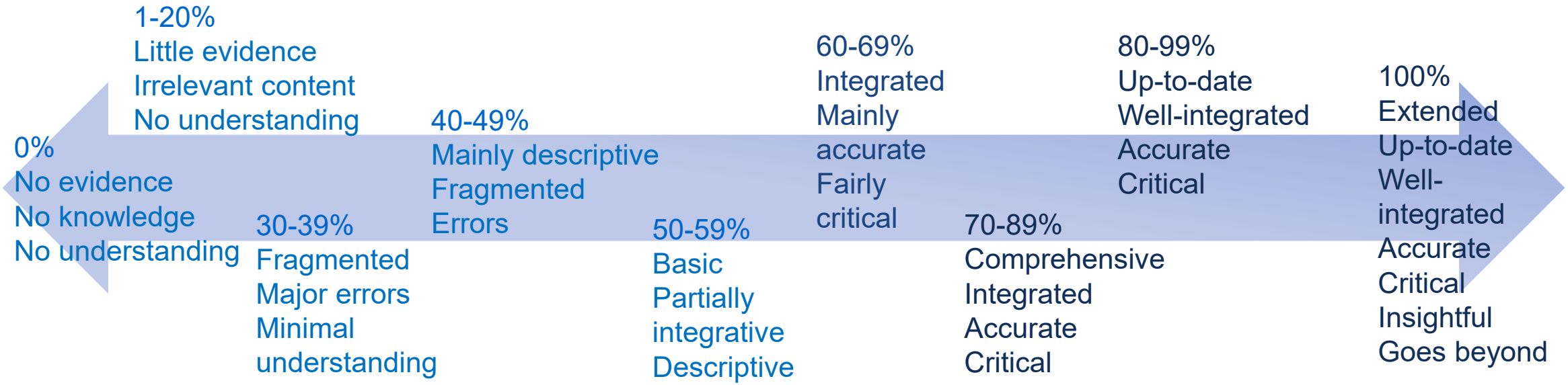
From Fail to Distinction

Performance levels	Poor (F-Fail)		Poor (D-Fail)		Satisfactory (C-Pass)	Good (B-Merit)	Excellent (A-Distinction)		
Score (as a % range)	0	1-29	30-39	40-49	50-59	60-69	70-79	80-99	100

Formulation of qualitative descriptors

Technique suggested by Andrade (2000)





General framework suggested for K&U based on (Biggs, 2003)

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Interactive Workshop

Aim: Select one assessment method and develop the corresponding assessment rubric

As a group you have the task to develop an assessment rubric for one assessment method of your choice. For this you need to define:

- The program level and the assessment method (Part 1)
- The learning outcomes to be assessed (Part 2)
- The assessment criteria (Part 3)
- The performance levels or rating scale (Part 4)
- The qualitative descriptions of each criteria at each performance level (Part 5)

Your group needs to designate one or more speakers to present your results in the plenary session

Pool of slides

Why is mapping important?

"'even when done to the highest standards, embedding opportunities for the development of graduate attributes in curricula, and mapping those opportunities in documented representations of curricula, will only produce a static snapshot of a curriculum' (Bath et al., 2004, p. 325). While this is an important limitation, such a static snapshot' does provide a starting point for academics and curriculum designers reflecting on current curricula, so they may design subjects and programmes that better enable students to develop the graduate capabilities they require within and beyond their university experience. In turn, these same mapping procedures can be used after changing a curriculum to evaluate the effectiveness of any redesign."

(Spencer et al., 2012)

Mapping curriculum categories

Categories of curriculum	Document analysis	Staff and faculty	Students
Declared	√		
Taught		√	
Learned			√
Assessed	√	√	√

Why is assessment important?

- Assessment determines what students will learn,
- Assessment determines how students learn, i.e. what they will do to learn
- Assessment is what determines the actual curriculum (Ramsden, 2003)
- “criteria-based assessment has been pointed out as a means to meet current demands on curricula design” (Nordrum et al., 2013, p.919)

Elements of curriculum design

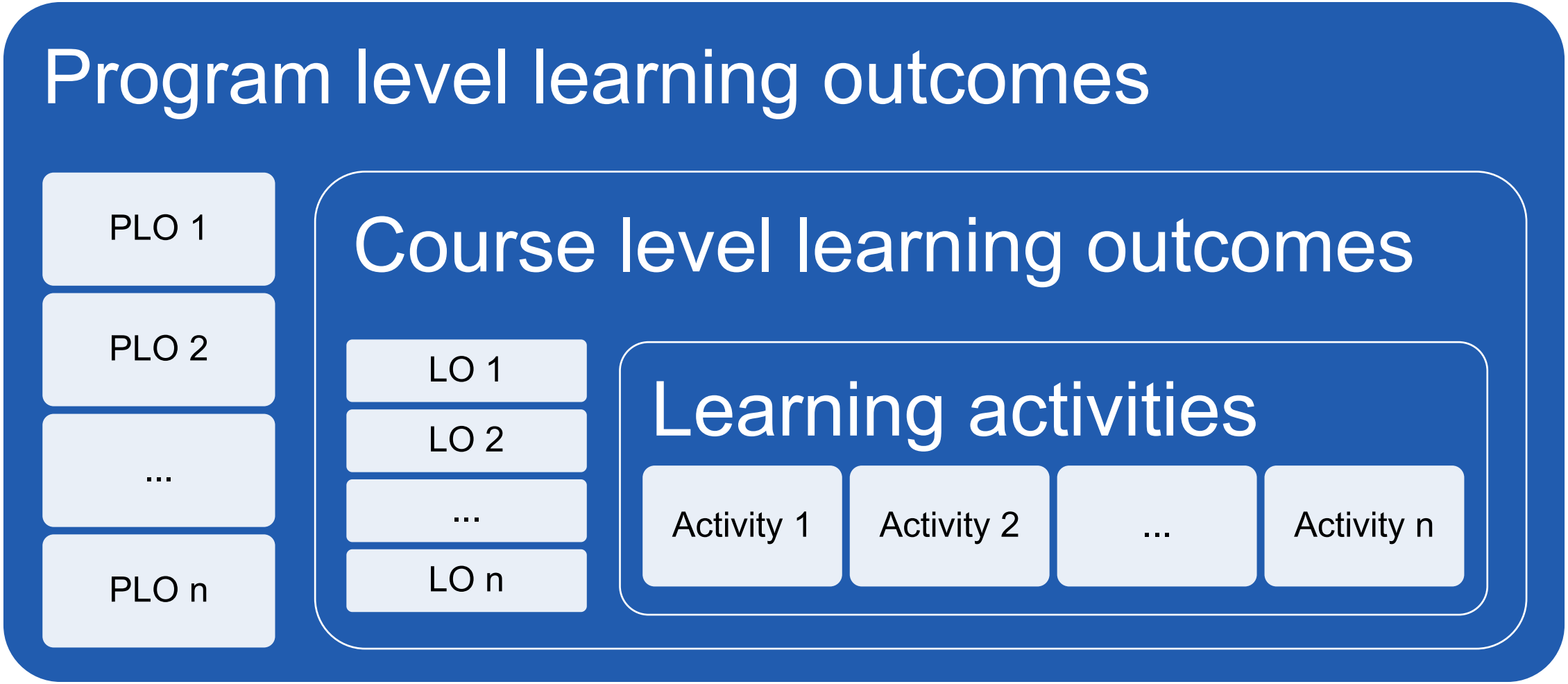
- **Competencies** (or intended learning outcomes)
  - what will students be able to do at the end of this study program?
- **Content** i.e. the topics to be covered by courses, lectures, labs, exercises, projects, seminars, etc.
  - What will students learn?
- **Teaching approaches**
  - How will students learn?
- **Learning activities**
  - What will students do (in order to learn)?
- **Assessment and Feedback**
  - How will students know that they have learned and what they should improve or work on?
- **Resources**
  - What is needed to facilitate students' learning?
- **Evaluation**
  - how do we know that what we are doing is what we intended to do and what the students achieve is what was intended to be achieved?

Cognitive level of the performance and typical verbs

1. REMEMBER	• list, define, tell, identify, show, label, collect, examine, tabulate, quote, name, • recognise, recall
2. UNDERSTAND	• describe, contrast, predict, associate, distinguish, estimate, discuss, extend, • interpret, exemplify, classify, summarise, explain
3. APPLY	• demonstrate, calculate, complete, illustrate, solve, modify, relate, change, apply, • experiment, discover, execute, implement
4. ANALYSE	• separate, order, connect, categorise, arrange, analyse, divide, compare • systematically, differentiate, organise, infer, attribute
5. EVALUATE	• assess, decide, rank, grade, test, measure, recommend, evaluate, convince, check, • critique, select, judge, discriminate, support, conclude, debate
6. CREATE	• develop, plan, produce, combine, integrate, rearrange, substitute, create, design, • invent, speculate, compose, formulate, prepare, generalise, rewrite, generate

Adapted from: Anderson, L.W., & Krathwohl, D.R. Eds. (2001). A Taxonomy for Learning, Teaching and Assessing. A Revision of Bloom's Taxonomy of Educational Objectives. New York: Addison Wesley Longman

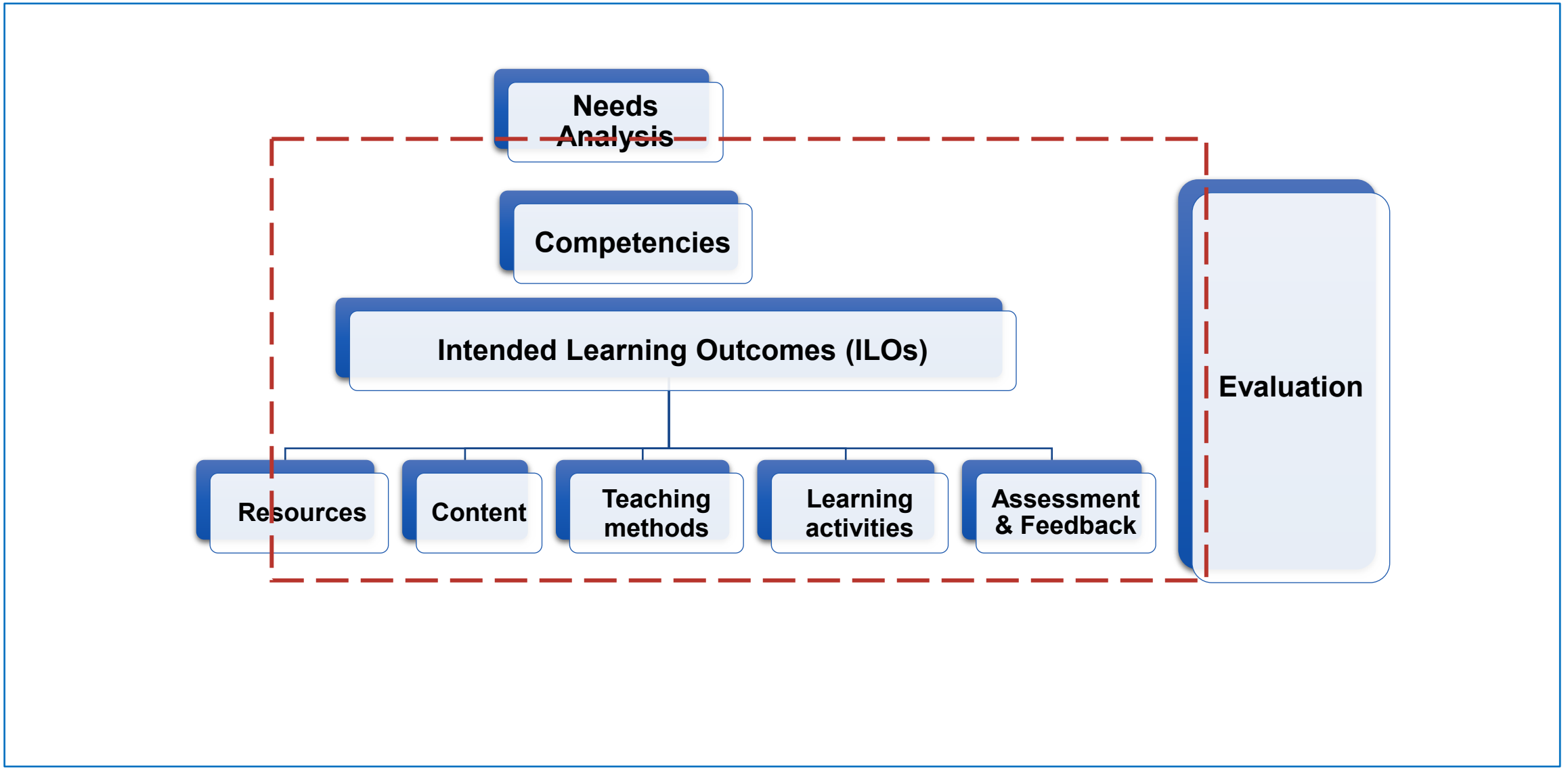
Mapping program LOs to course Los to learning activities



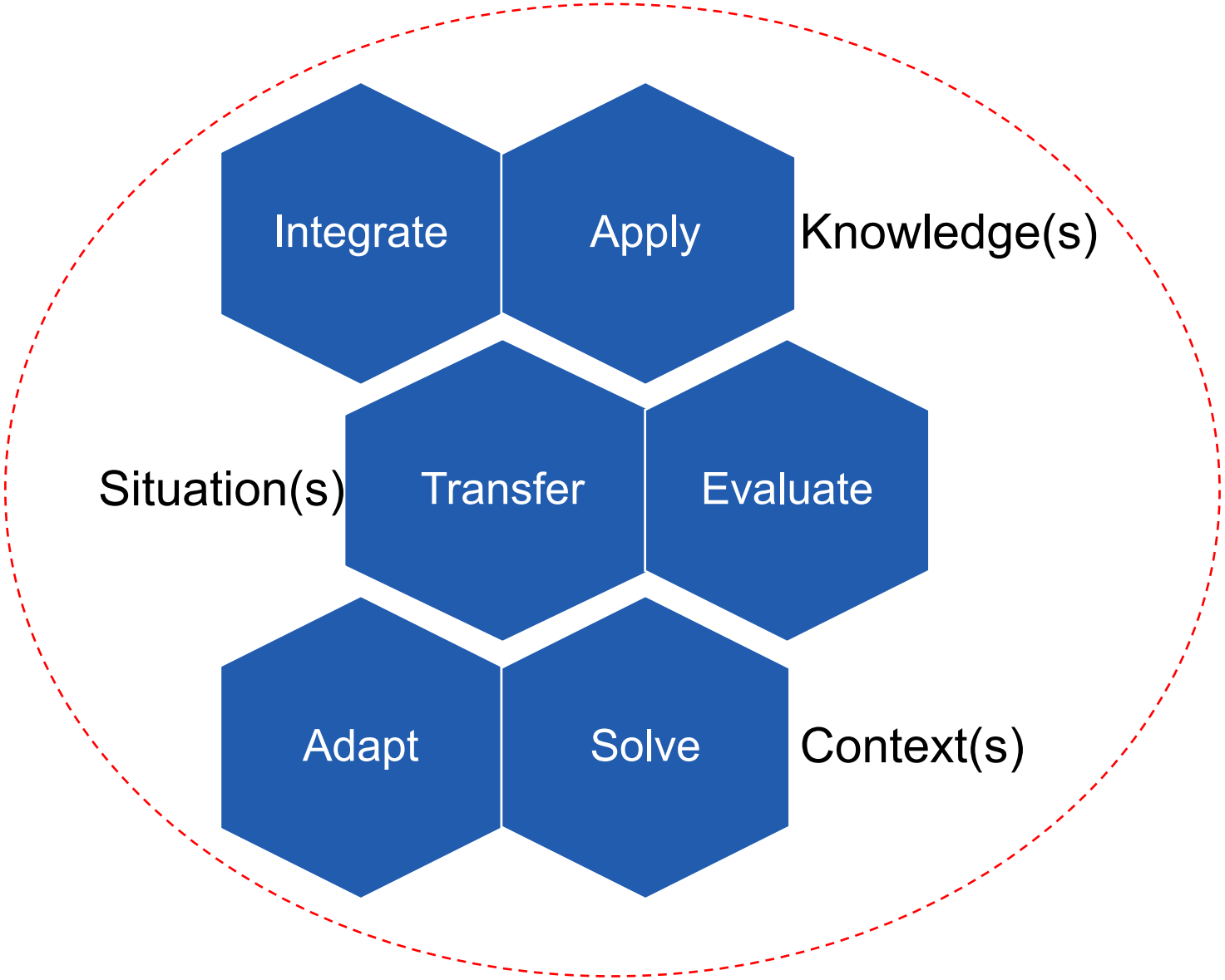
Examples of assessment strategies

Oral presentations	Posters	Video productions	Consultancy reports
Technical reports	Group discussions	Essays	Group projects

Alignment by Design



How to assess a competency: integrated elements

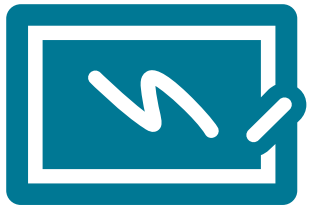


Example 1: Interdisciplinary Engineering Curriculum at ETH Zurich

Alignment at program level

Knowledge, methods, and skills in disciplinary contexts

Existing courses



Opportunities for integrative learning

Projects

Workshops

Seminars

Assessment of students' integrative ability

Connect

Synthesise

Innovate

Transfer

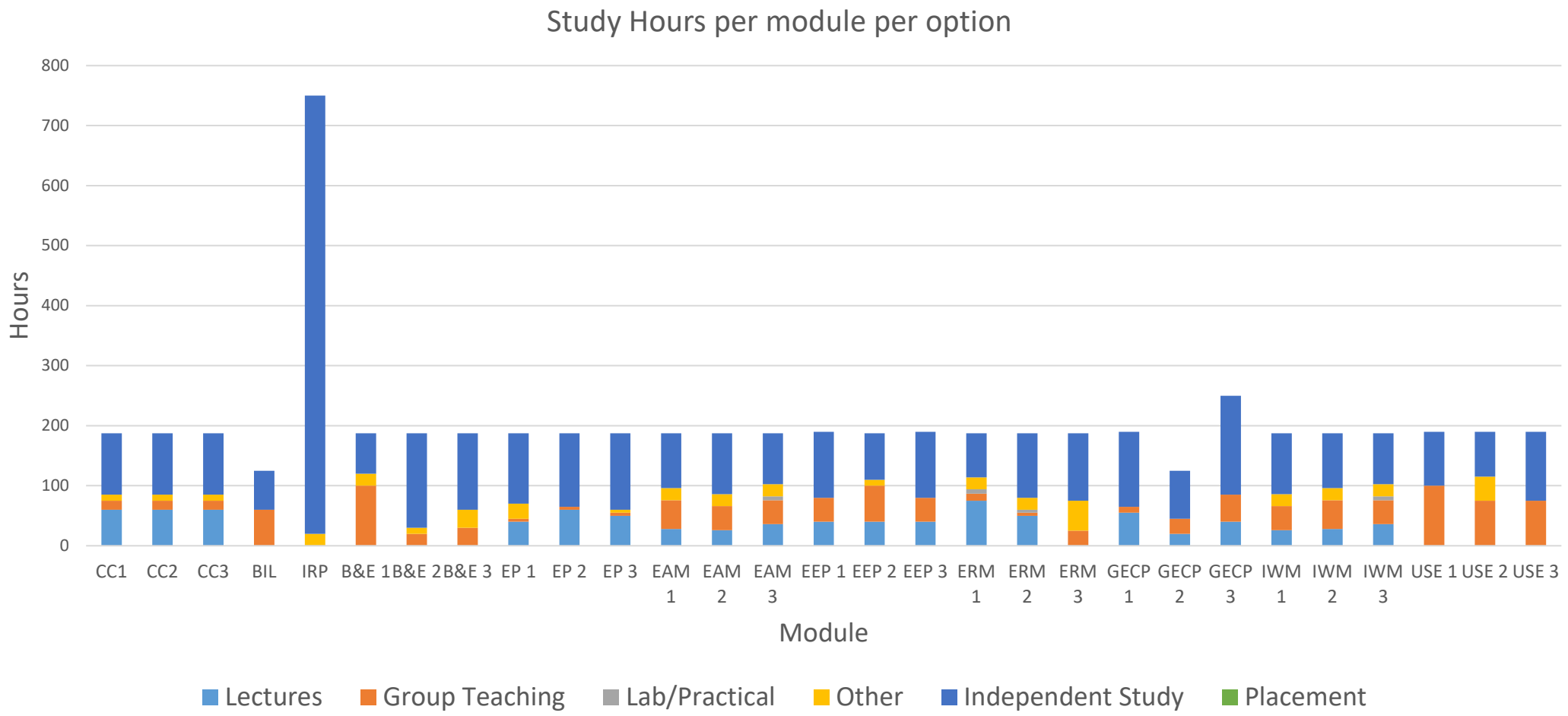
Example 1: how to achieve alignment in curriculum design?

Foundational knowledge	Disciplinary learning	Interdisciplinary learning
• Compulsory courses • Disciplinary context • Predefined LOs • Established assessments	• Elective courses • Disciplinary context • Predefined LOs • Established assessments	• Seminars and workshops • Integrative context • Targeted LOs • New assessments

Integration

Project-based learning (PBL)

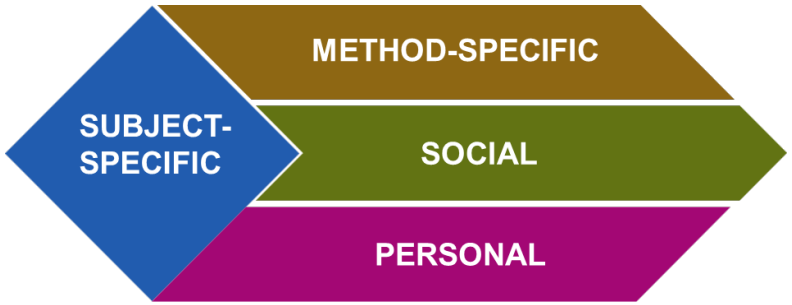
Teaching methods



ETH Competence Framework:
20 competencies grouped into 4 domains

- Subject-specific competencies
  - Concepts and theories
  - Techniques and technologies

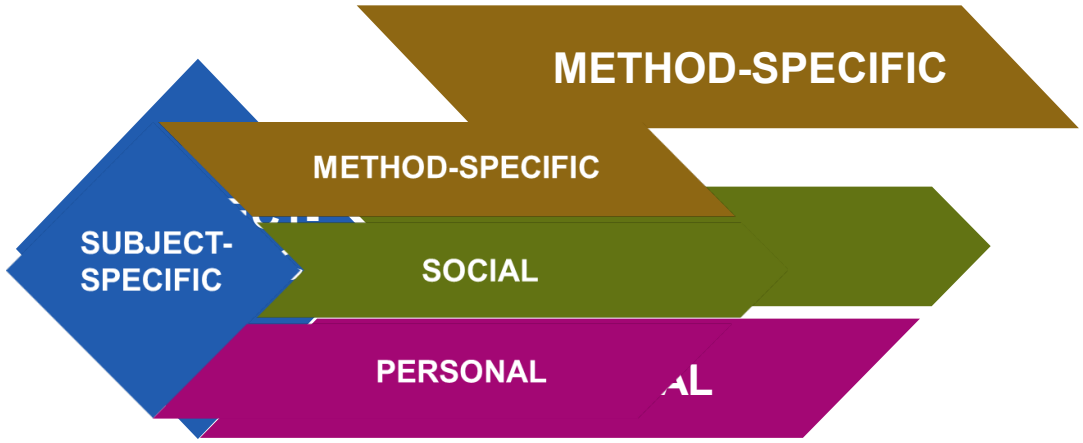
- Method-specific competencies
  - Analytical competencies
  - Decision-making
  - Media and digital technologies
  - Problem solving
  - Project management



- Personal competencies
  - Adaptability and flexibility
  - Creative thinking
  - Critical thinking
  - Integrity and work ethics
  - Self-awareness and self-reflection
  - Self-direction and self-management

- Social competencies
  - Communication
  - Cooperation and Teamwork
  - Customer orientation
  - Leadership and Responsibility
  - Self-presentation and social influence
  - Sensitivity to diversity
  - Negotiation

ETH Competence Framework



- **Competency as a set of knowledge, skills, attitudes**
- **Method-specific competencies**
  - **Analytical Competencies:** Ability to break down processes and systems into parts while understanding their interaction
  - **Decision-making:** Ability to define a decision and a set of alternative actions from which to choose
  - **Media and Digital Technologies:** Ability to access, evaluate, and use media and digital technology
  - **Problem-solving:** Ability to define a problem and find solutions for it
  - **Project Management:** Ability to manage projects and produce results

Competency as a set of knowledge, skills, and attitudes

METHOD-SPECIFIC

- **Analytical Competencies:** Ability to break down processes and systems into parts while understanding their interaction
- **Decision-making:** Ability to define a decision and a set of alternative actions from which to choose
- **Media and Digital Technologies:** Ability to access, evaluate, and use media and digital technology
- **Problem-solving:** Ability to define a problem and find solutions for it
- **Project Management:** Ability to manage projects and produce results

- **Knowledge:**
  - Knowledge about decision making processes and tools
  - Knowledge of bias, risks, and evaluation techniques in decision-making
- **Skills:**
  - Ability to recognise a decision-making problem as such
  - Ability to phrase alternatives
  - Ability to evaluate alternatives and choose among them
  - Ability to make a decision also in case of incomplete information
- **Attitudes:**
  - Minimise bias, risks and uncertainties when making decisions
  - Be aware of the way emotions can affect the evaluation of alternatives