



# AI, Creativity and Critical thinking in Higher Education

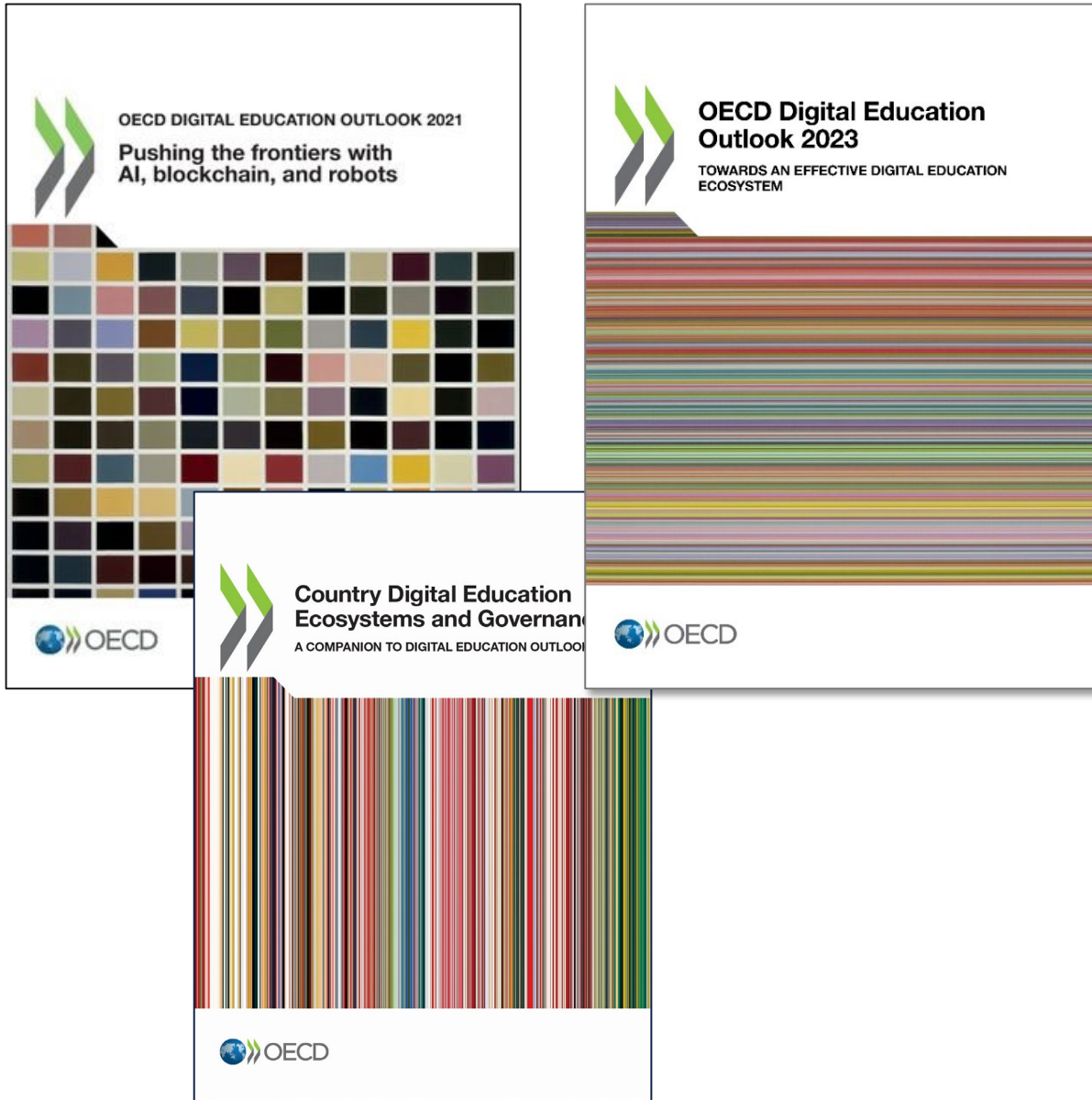
## Opportunities and challenges

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# OECD Digital Education Outlook



## 2021

- What are the current frontiers of AI and other technologies in education?
- What are the upcoming challenges?

## 2023

- What soft and hard infrastructure do countries provide to support digital education?
- How do countries govern the main aspects of digital education (privacy, procurement, interoperability, genAI, development, implementation, etc.)?

## 2026

- Promises (and pitfalls) of Generative AI

**1**

**GenAI in teaching and learning in HE:  
Emerging evidence**



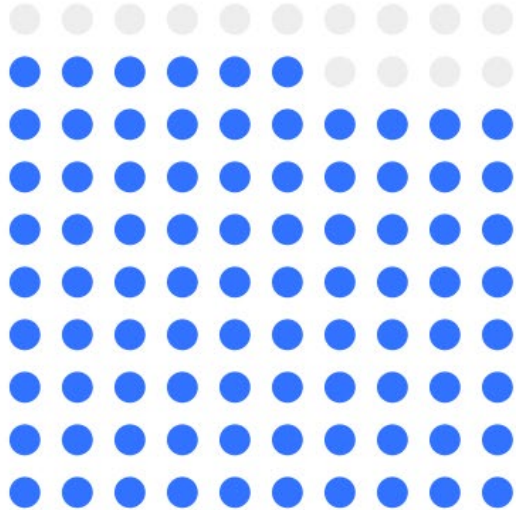
# University students seem to use (generative) AI

## Percentage of students using AI in their studies

Question: How often do you use AI tools?

**86%**

of students claim to use AI in their studies



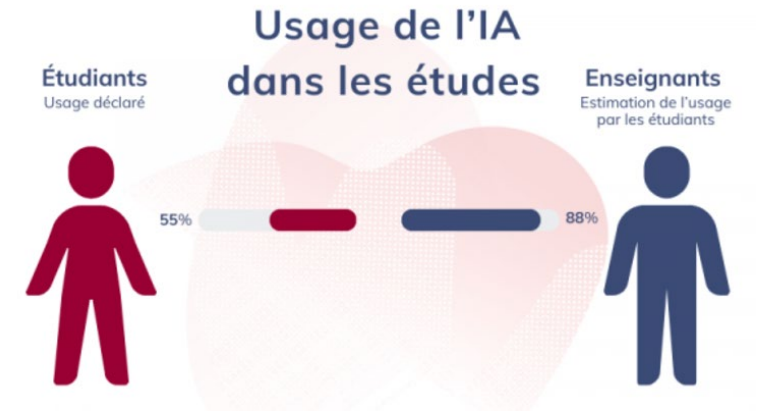
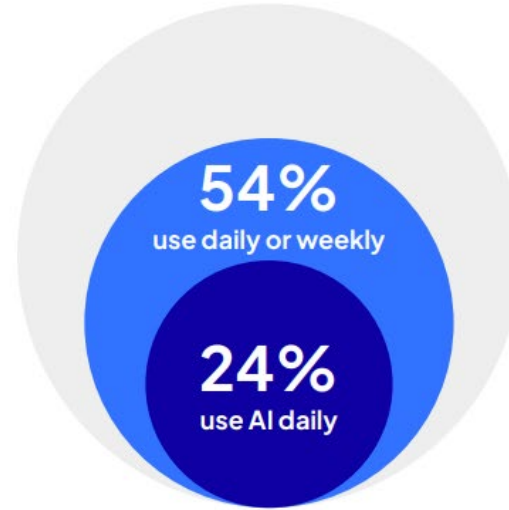
(Non-representative) survey of HE students in 16 countries

## Frequency of students using AI in their studies

Question: How often do you use AI tools?

**54%**

of students use AI at least on a weekly basis

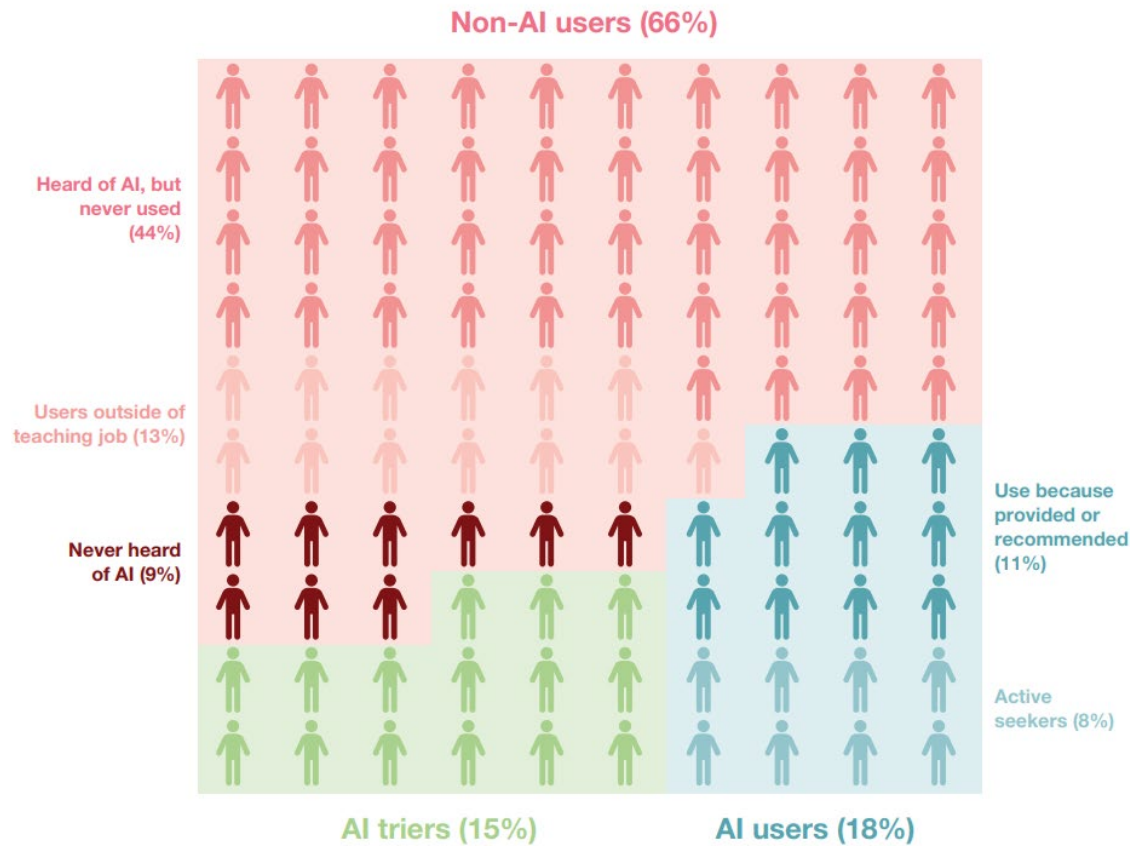


France: **55% of HE students** report using AI and according to university teachers this would be **88%**



# And school teachers and pupils increasingly (from 33% to 73%)

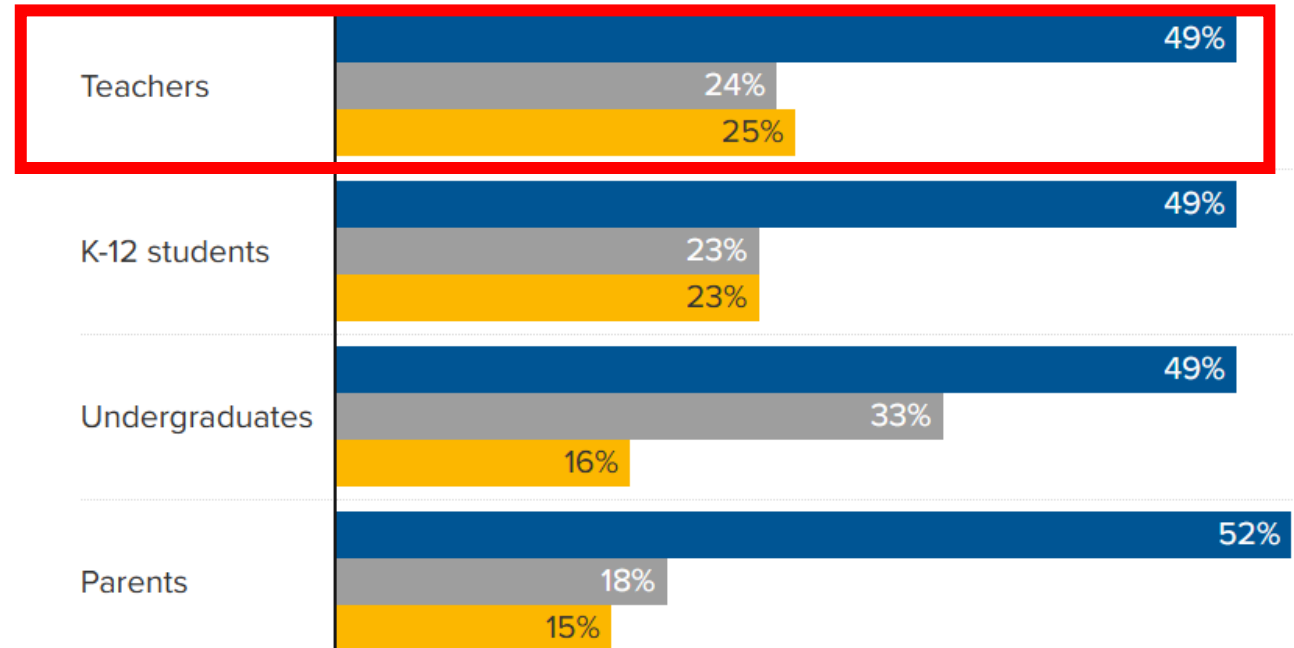
United States (Fall 2023)



United States (Spring 2024)

## About half of teachers, students and parents are using AI chatbots at least once a week for work or school

■ Once a week or more ■ Every once in a while ■ Never



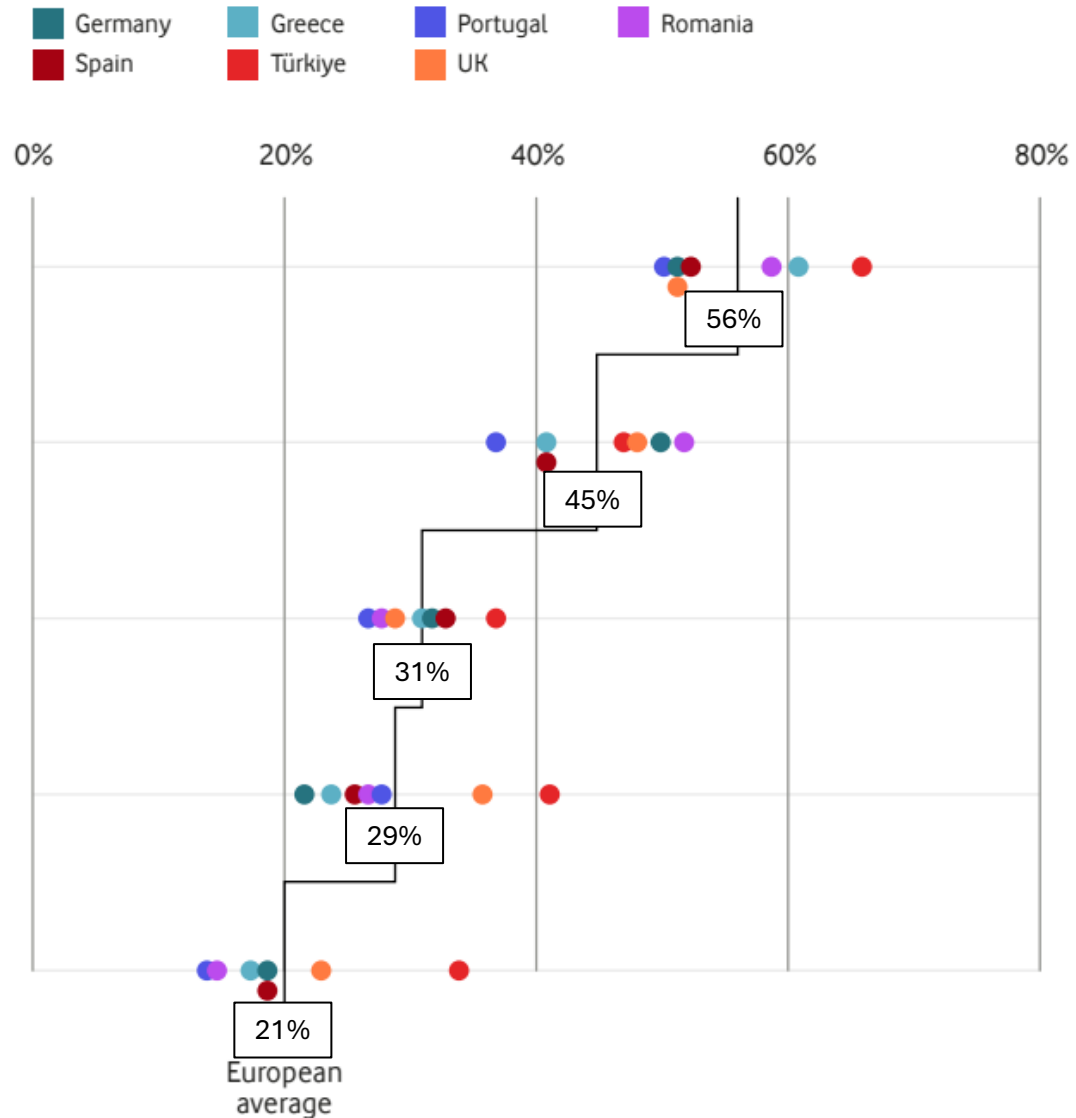
Source: Impact Research

Online survey of 4,007 teachers, parents and students in the U.S. conducted May 7-15, 2024



# On their own, students use Generative AI as an augmented search engine more than as an interactive tool

“What do you currently use AI applications for when learning **outside of school** and **not being instructed** by your teachers?”



From consultation...

... to interactivity



generative AI



risks



## Example 1: Short and longer term effects of AI (Turkey)

1000 high school students in Turkey (grades 9, 10, 11)  
on logic and arithmetics

### Randomised control trial:

- 1) All students get taught the maths content
- 2) Practice the taught content with 3 conditions:
  - 1) They learn with course notes and textbook (control)
  - 2) They learn with general LLM (GPT base)
  - 3) They learn with instructional LLM (GPT Tutor)
- 3) All groups take same test (with no GPT)





## Example 1: Short and longer term effects of AI (Turkey)

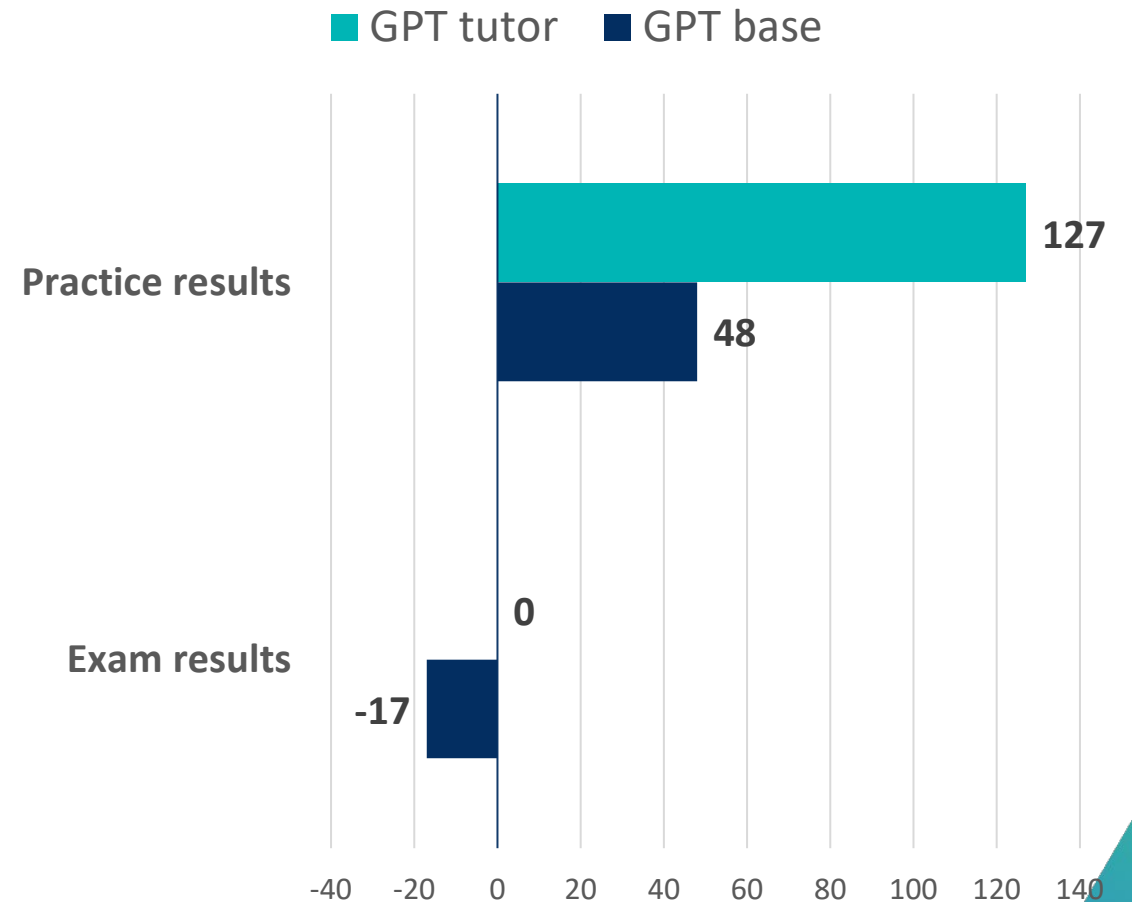
Increased performance (correct solutions) during practice for both GPTs, with much stronger one for GPT Tutor

Inferior performance of GPT base and similar performance at exam (with no GPT)

One reason is that those using GPT base asked for (and got) the answer during practice (and thus learnt less)

Strong engagement of students during practice mode

Percentage increase/decrease in performance compared to control group





# Example 2: How cooperation between humans and AI compare

## A risk of metacognitive laziness

**Question:** Comparing learners' motivations, self-regulated learning processes and learning performances on a writing task among different groups who had support from different agents

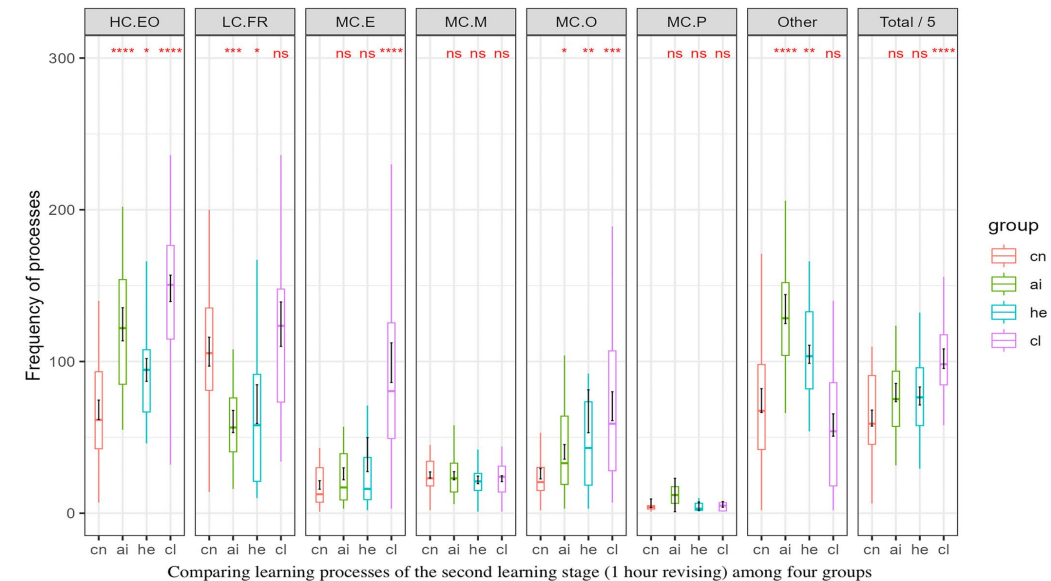
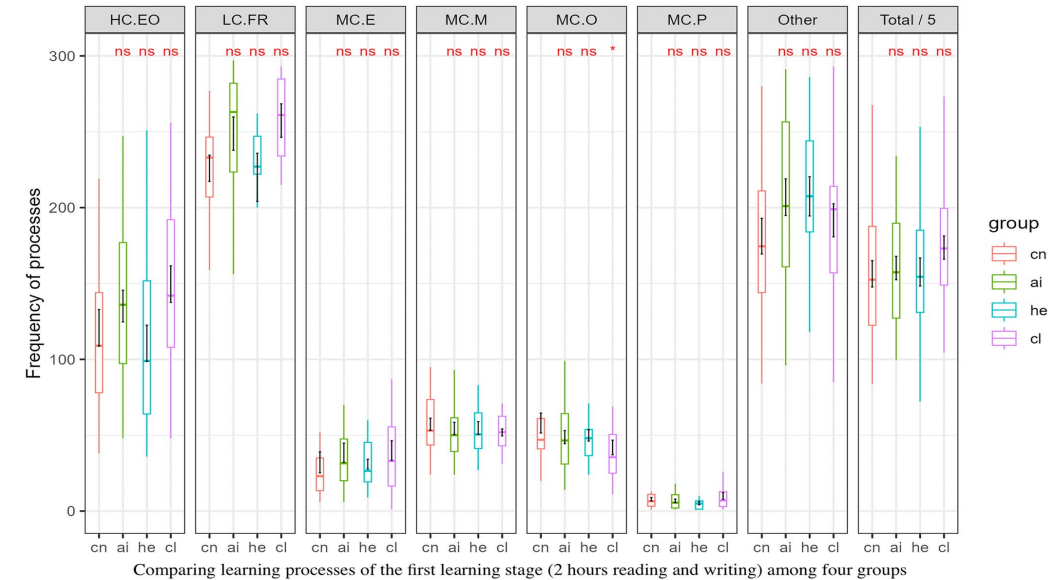
**Randomised Control Trial with 4 treatment groups with pre-post tests/observations:**

1. Human alone
2. Human with human expert
3. Human with Generative AI
4. Human with Check list (and digital tools)

### 2 phases:

- 1) Everyone writes alone
- 2) Revision of draft under the 4 treatments

**Level:** Higher education





## Example 2: How cooperation between humans and AI compare

### A risk of metacognitive laziness

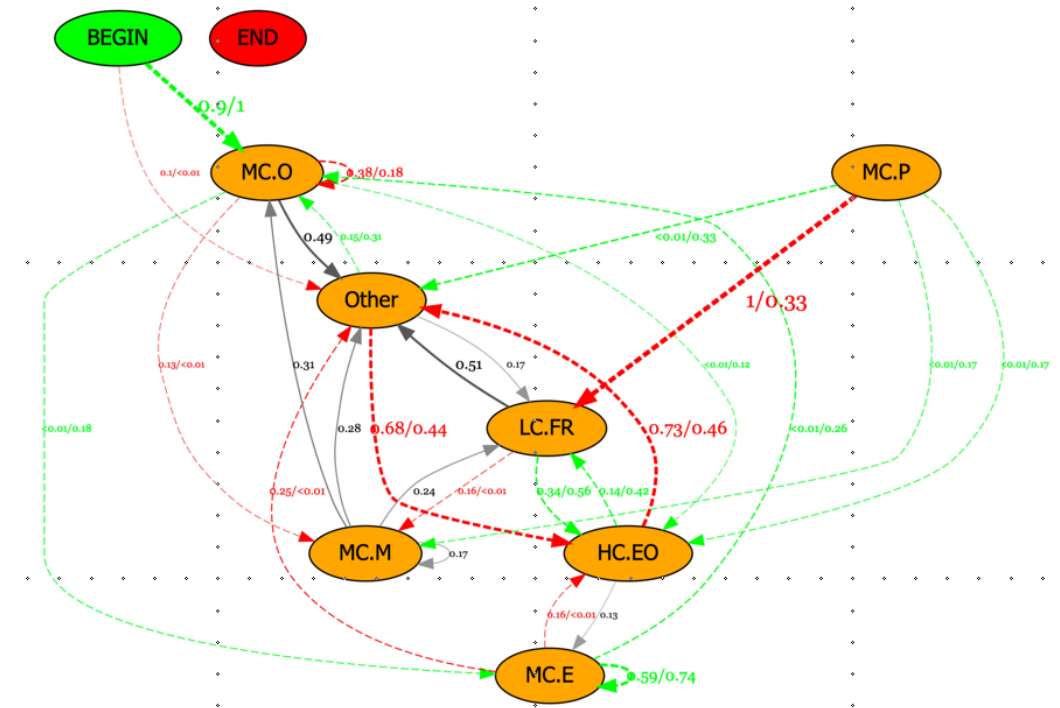
**Learning motivation:** No statistically significant differences – but group with interactions are slightly more motivated, and group with checklist are most intrinsically motivated

**Performance on task:** The **AI group get the best scores** (possibly because the AI follows the scoring rubric better)

**Knowledge gain:** There is **no difference in knowledge gains across groups** (so that the higher performance of AI group does not translate into improved knowledge)

**Processes:** The **AI group perform less metacognitive tasks** (evaluation and orientation) compared to groups with human experts or with checklist.

Risk of metacognitive laziness with thinking process outsourced to machine?



Comparing process maps of the revising stage between AI and HE groups



## Example 3: How students seek help from humans and from LLMs (China)

### Question:

Do students have different processes when seeking help from LLMs and human experts?

### Method:

- RCT with 38 university students starting by writing an essay in English by themselves
- 2 conditions for revising one's essay:
  - ♦ Seek help from ChatGPT
  - ♦ Seek help from human expert
- Measures: telemetry and observation
- Four help seeking activities:
  - ♦ Diagnosing question
  - ♦ Asking Help
  - ♦ Evaluating Help
  - ♦ Processing Help

Chinese native-speakers writing an essay in English

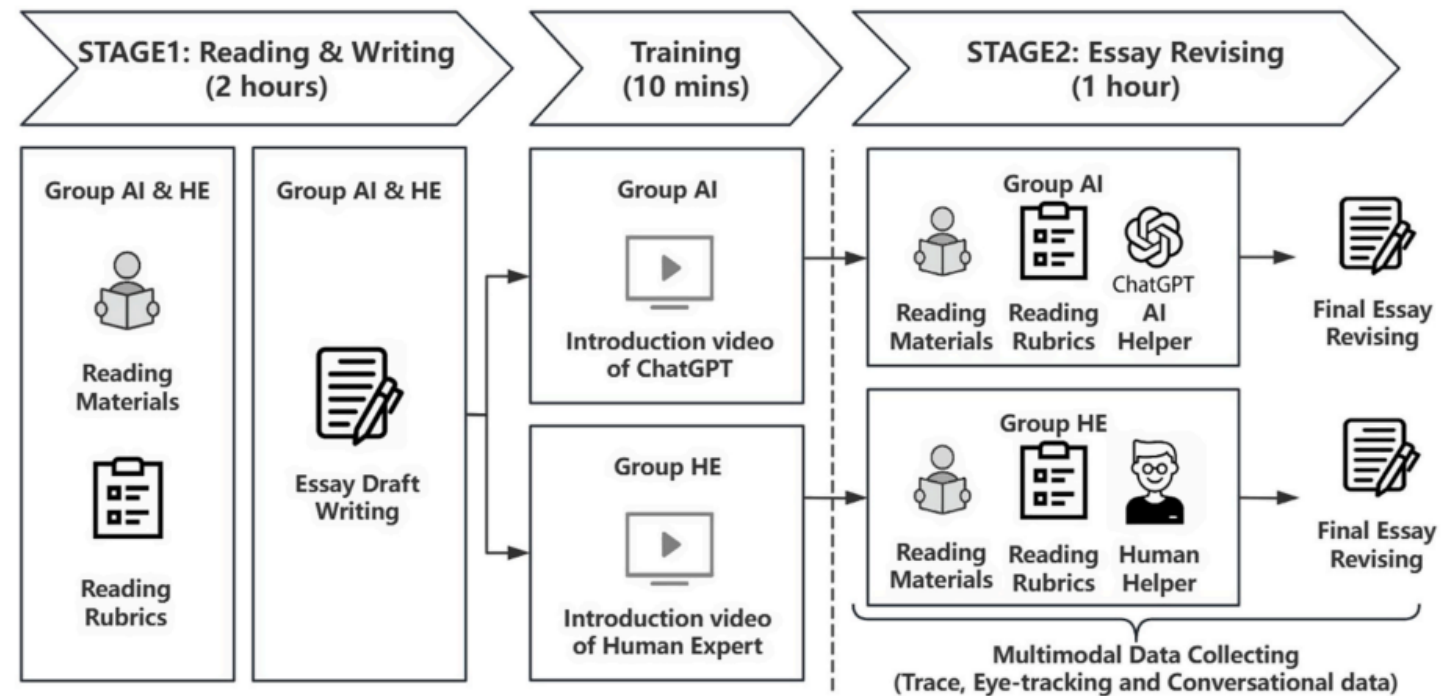


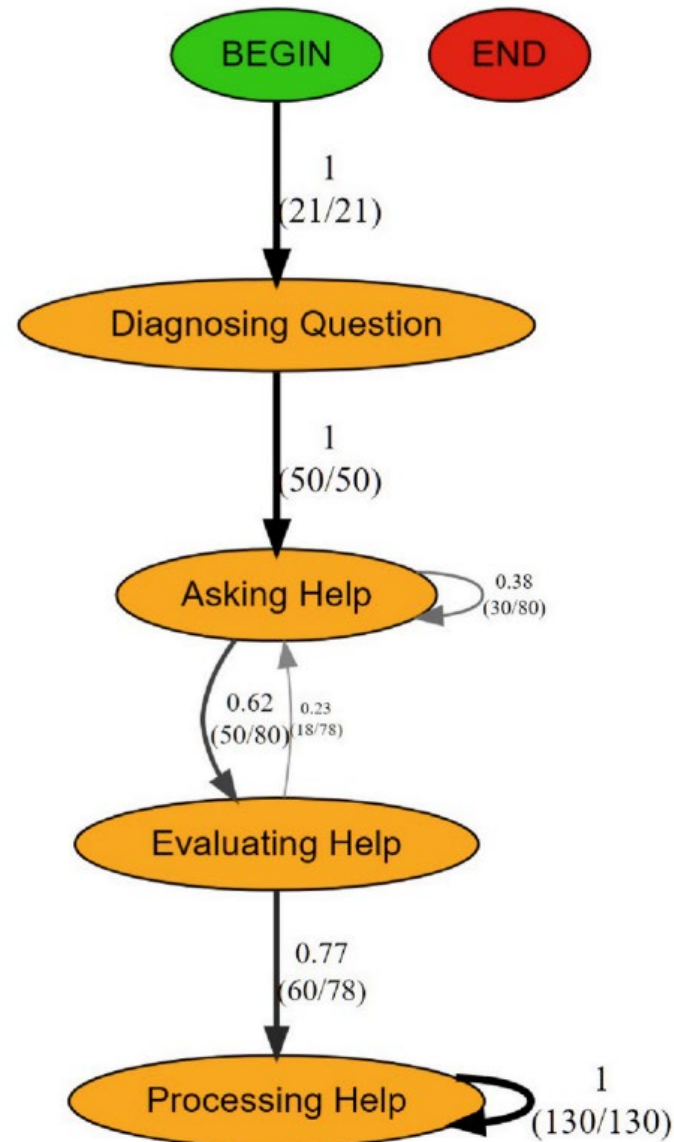
Fig. 1. Experiment procedure.



## Example 3: How students seek help from humans and from LLMs (China)

### Findings

- 1) The “human” group seeks help in a linear way, following the classic “help seeking” theory





## Example 3: How students seek help from humans and from LLMs (China)

### Findings

- 1) The “human” group seeks help in a linear way, following the classic “help seeking” theory
- 2) The human-LLM group has a more “circular” strategy and uses less “diagnosing” questions and evaluate less the help : **more “operational” approach**
- 3) Difference: more evaluation of help by humans, more processing of help by AI group – more thinking vs more tinkering?

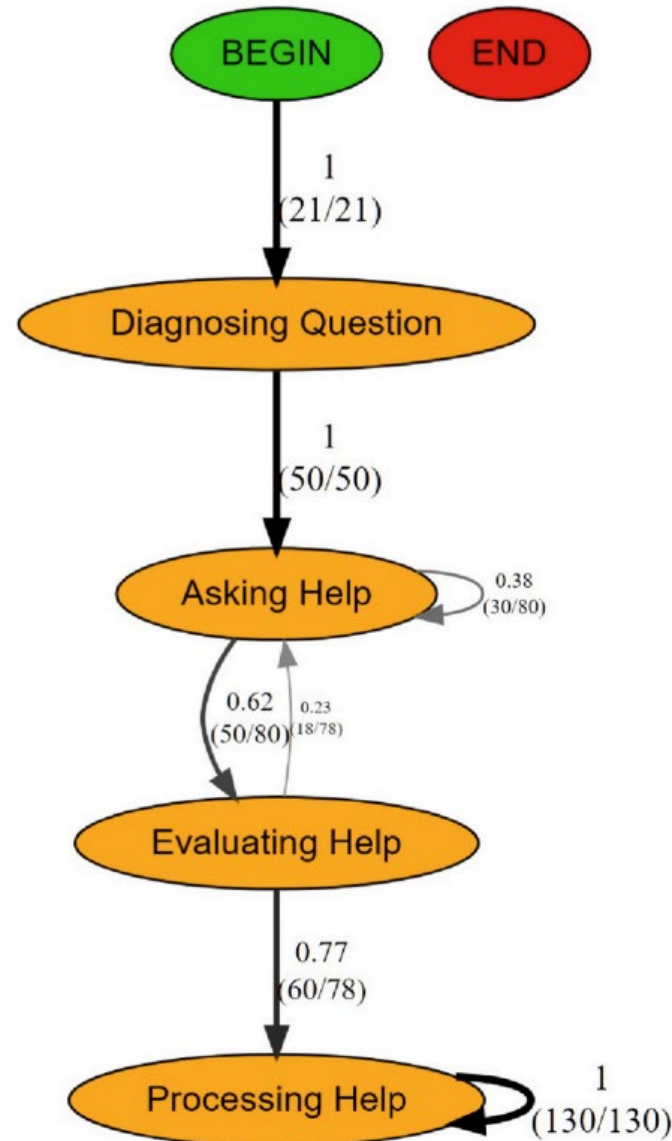


Fig. 5. Help-seeking process temporal pattern in stages in HE Group.

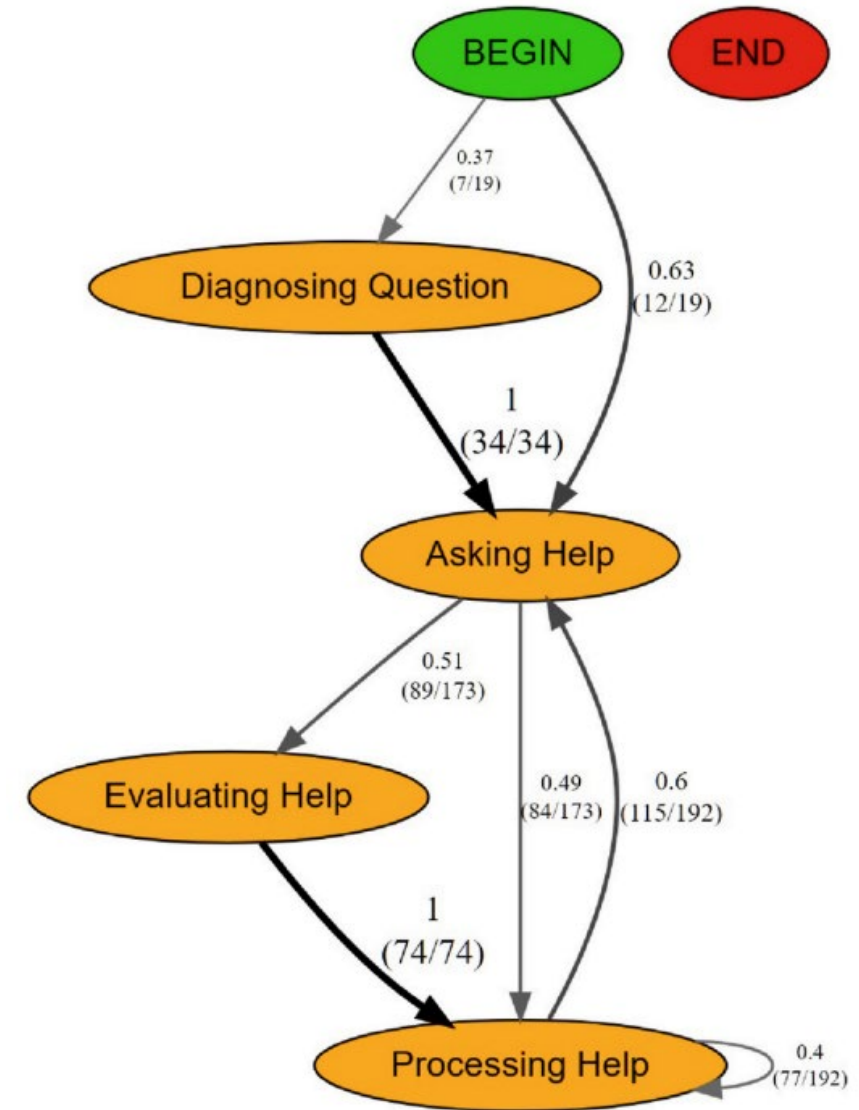


Fig. 4. Help-seeking process temporal pattern in stages in AI Group.



# Example 4: Brain activation and recall when using LLM, Search engine and brain only (US)



Welcome Onboarding



Enobio headset setup



Blinking test (2 minutes)



Mental Math Test (2 minutes)



Essay (20 minutes)






Post-assessment interview (5 minutes)



Schedule next session. Debrief, cleaning up

**Groups**

LLM 	Topic A	Topic D	Topic G	Topic A or D or G
Search Engine 	Topic B	Topic E	Topic H	Topic B or E or H
Brain Only 	Topic C	Topic F	Topic I	Topic C or F or I

Session 1

Session 2

Session 3

\*Session 4

**Sessions**

\*optional session 4

## Question:

What is student cognitive cost and recall when using an LLM in the educational context of writing a 20-min essay?

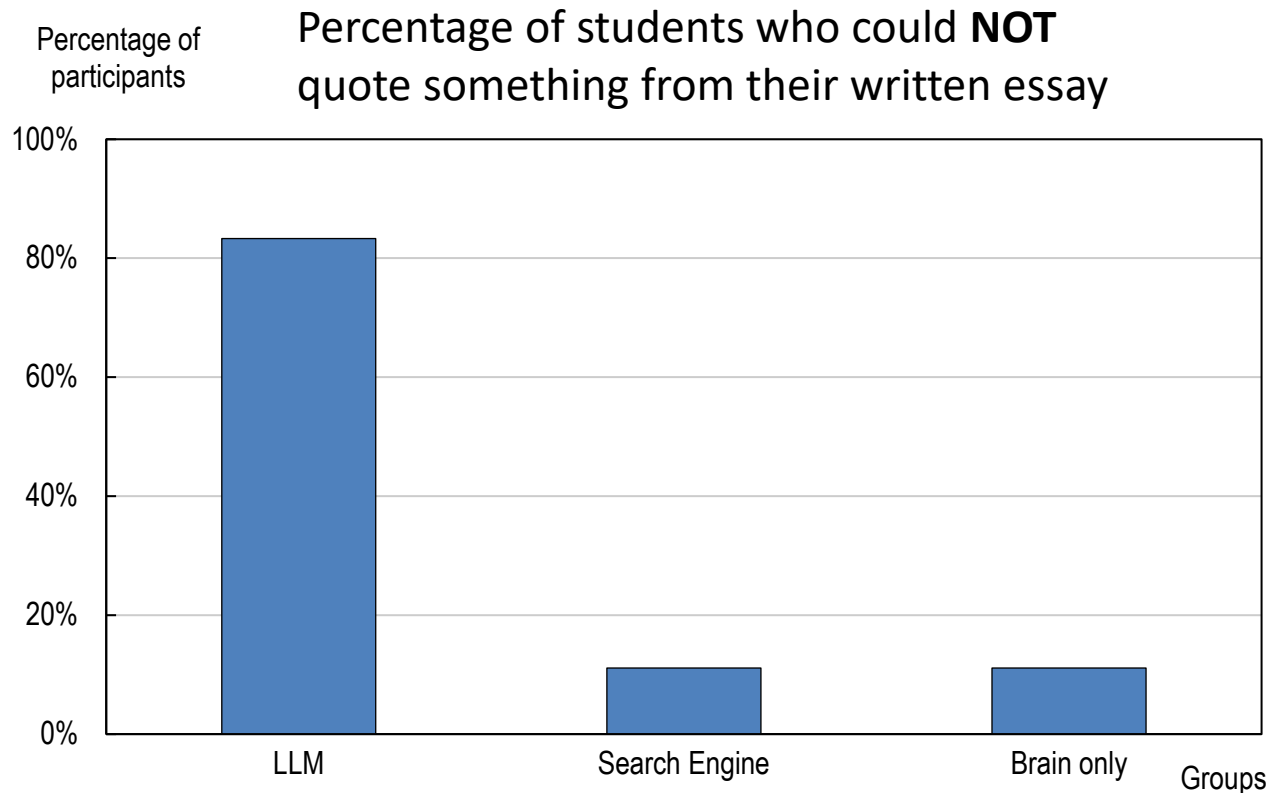
## Method:

- RCT with 54 university students aged 18-39, recruited from 5 universities in Boston area
- 3 conditions:
  - ♦ Writing with an LLM
  - ♦ Writing with search engine
  - ♦ Writing with no assistance (“brain only”)
- Students in each condition can choose to write about 3 possible topics
- In an optional session, those who were assigned to the LLM group write as “brain only” and vice-versa.



# Example 4: Brain activation and recall when using LLM, Search engine and brain only (US)

***Students writing with the LLM struggled to quote anything from their written essays***



## Post-task assessment:

LLM group had

- ◆ most limited ability to quote something from their written essay (recall)
- ◆ lower ability to summarise their essay's viewpoint
- ◆ lower level of ownership
- ◆ more homogeneity in essay content

## Brain imagery:

LLM group:

- ◆ shifted their executive tasks from generating content to supervising the AI-generated content
- ◆ had less neural connectivity and less executive involvement



possibilities

# Example 1: Fostering creativity and communication

Writing (short) stories with and without GenAI ideas

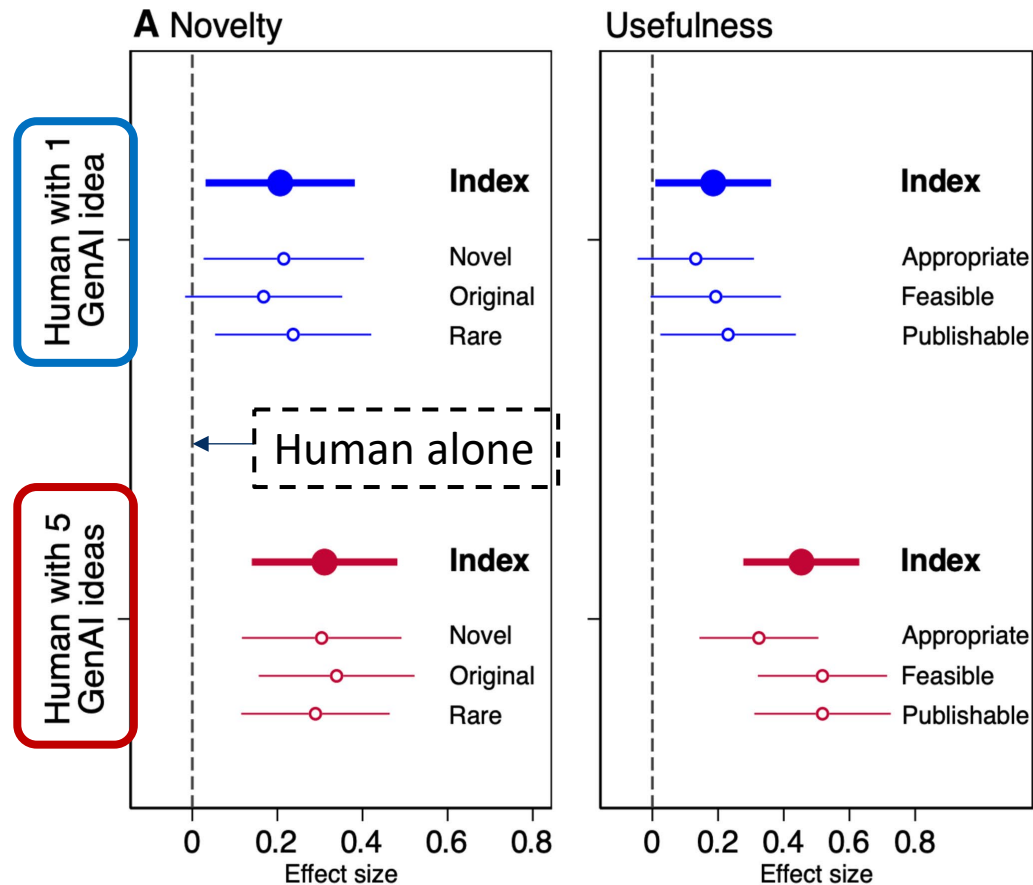


Fig. 1. Visual representation of experimental design.



# Example 1: Fostering creativity and communication

293 people writing (short) stories with and without GenAI ideas



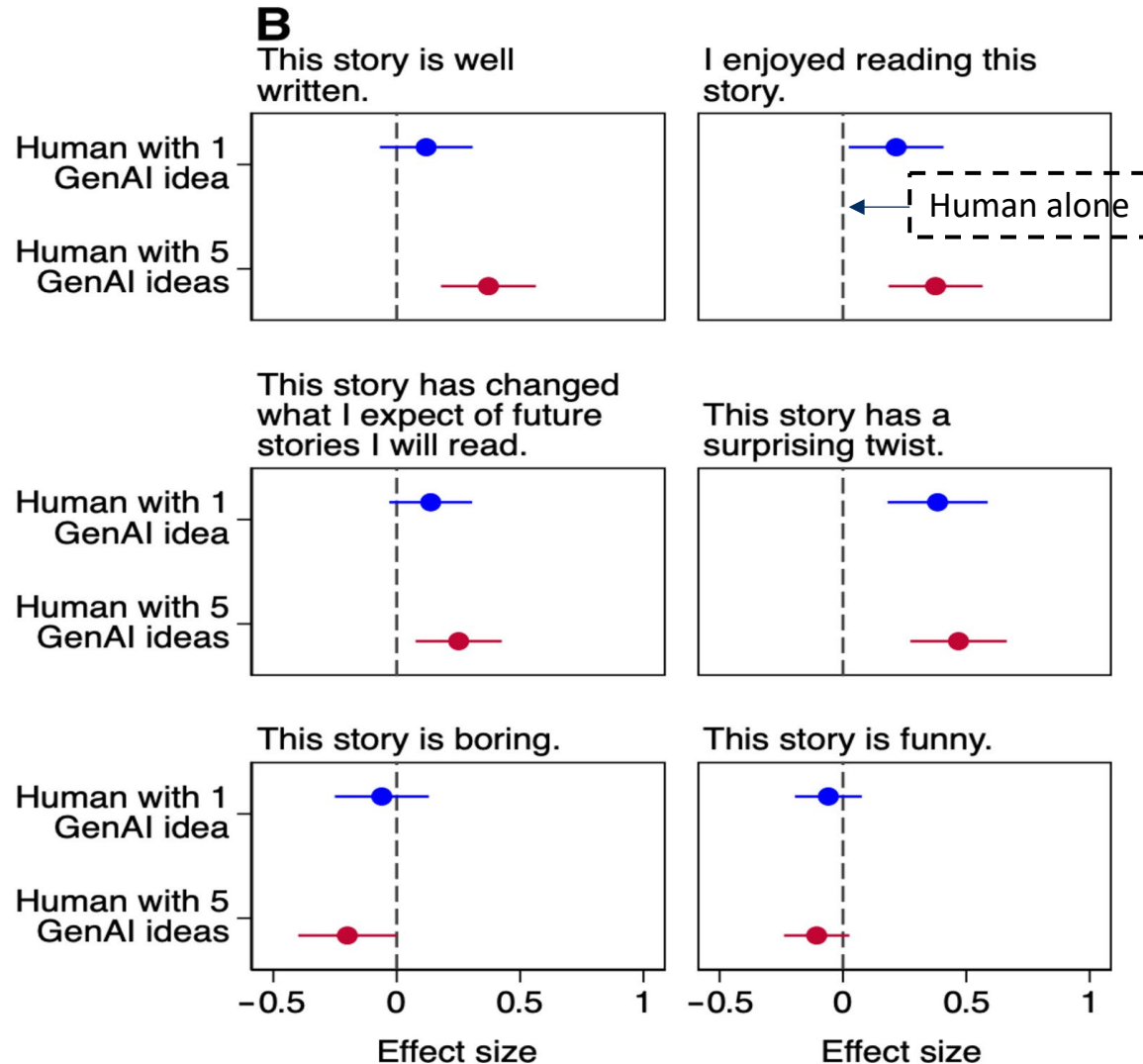
Access to generative AI ideas leads to stories evaluated (by humans) as:

- More creative (especially among less creative writers)



# Example 1: Fostering creativity and communication

293 people writing (short) stories with and without GenAI ideas



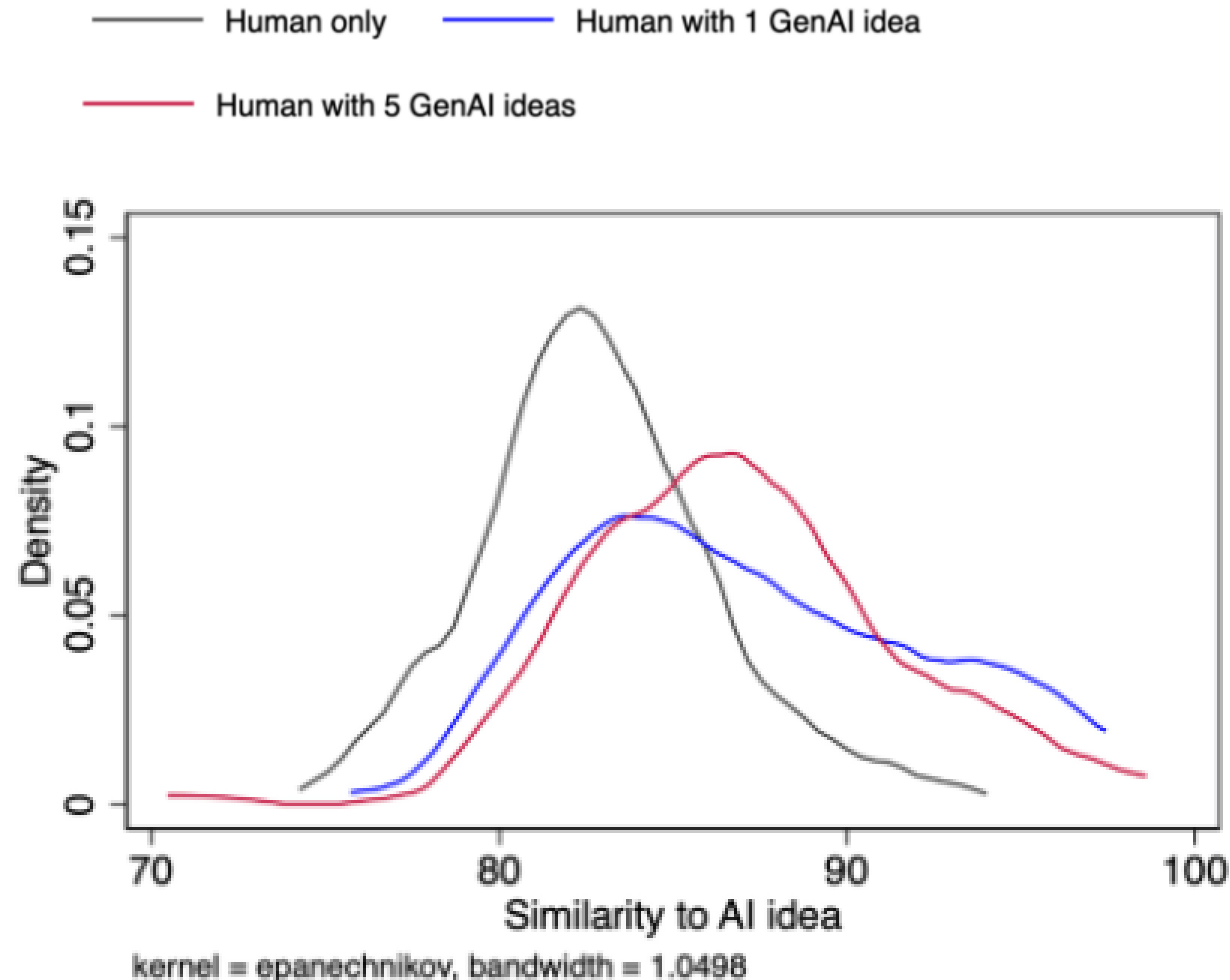
Access to generative AI ideas leads to stories evaluated (by humans) as:

- More creative (especially among less creative writers)
- Better written
- More enjoyable
- But (slightly) less funny



# Example 1: Fostering creativity and communication

## Writing (short) stories with and without GenAI ideas



**But** the pools of GenAI-assisted stories exhibit **higher similarity** (less variety) to an AI production and with each other than the pool of human-only stories.

→ Increase in creativity of individual output and writing effectiveness at the risk of losing collective novelty?



## Example 2: Keeping same learning gains with or without LLM in computer programming course (Slovenia)

**Question:** How to change the tasks and assignments so that the access to ChatGPT does NOT make a (negative) difference on learning?

**Controlled Experiment with 182 1<sup>st</sup>-year HE students in 2 groups** (object-oriented programming):

1. Use of ChatGPT for practical assignments
2. No use of ChatGPT for practical assignments

**Course structure (15 weeks):**

- 1) 11 mandatory and 11 optional home practical assignments
- 2) Lectures followed by Lab session in which each student has an extended assignment and an **oral defence** of their home programme
- 3) 2 **paper-based** mid-terms

**Results:**

- Same results for both groups on lab work and on mid-term exam (slightly higher for Group 1 but not statistically significant)
- The ChatGPT group had the impression it had learnt more than the non-GPT group



## Example 2: Keeping same learning gains with or without LLM in computer programming course (Slovenia)

### How did it work?

- **Revised assignments:**
  - ♦ Instructors checked what ChatGPT does easily and provided assignments that are less convenient or require more knowledge for good prompting
  - ♦ Use Lab sessions to extend home assignments (with no help of ChatGPT)
- **Oral defence of produced computer programmes (with Teacher Assistants)**
  - ♦ Conceptual questions (explaining part of their programming code emphasising object-oriented concepts)
  - ♦ Code analysis (search in code for specific functionality)
  - ♦ Code changes questions (minimal change in the object-oriented part of the programs that change the code's behaviour)
  - ♦ Code completion questions (demonstration of using object-oriented code in the main program)
- **Mid-term exams**
  - ♦ Mainly based on theoretical questions
  - ♦ NB: Paper format annoyed students to some extent



## Example 3: Learning (more) by Teaching a GenAI in computer science (China)

**Question:** Does a teachable LLM have a positive impact on knowledge, programming and self-regulated learning skills?

**41 HE students in 2 groups:**

1. Learning through videos and then by teaching a ChatGPT student
2. Learning through videos and then practicing by themselves

### Results:

- “Teach GenAI” group perform better than other group on: **knowledge**, **clarity** and **readability** of programme, and on **self-efficacy** and **cognitive strategies**
- No difference for **correctness** of programme though (perhaps because even as a student ChatGPT may not make enough coding mistakes)

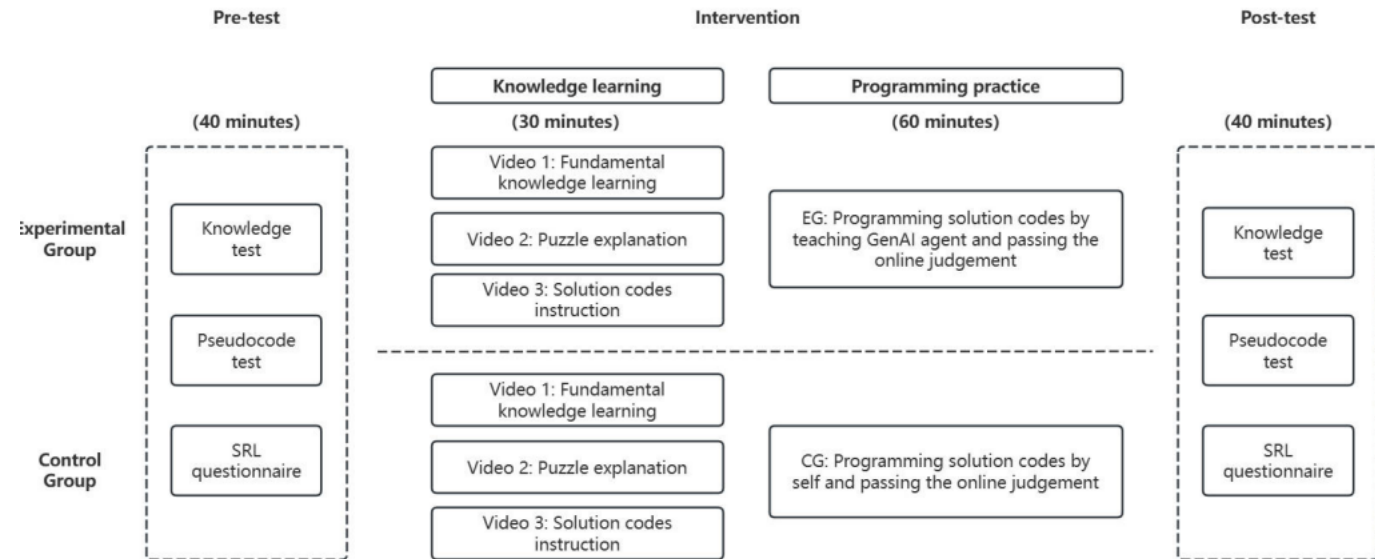
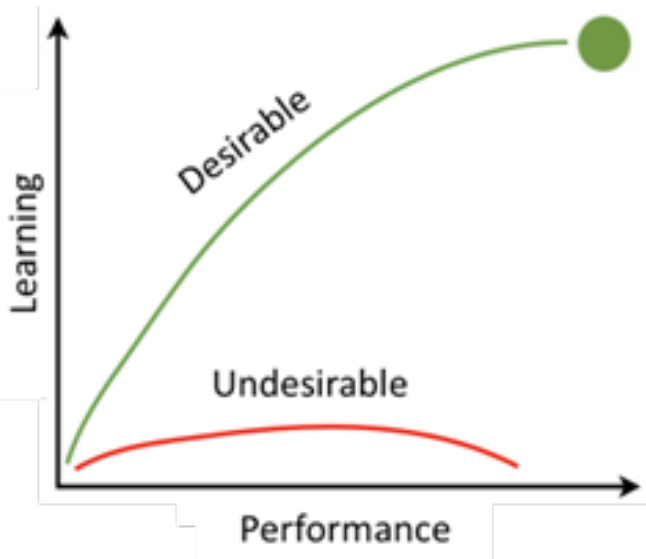


Figure 3: Procedure of the experiment



## What does this mean for HE?



- Become clearer about **fundamental knowledge** in a course/discipline are: what should students know to be able to « correct » and interact properly with a GenAI?
- Have **dual modes of teaching/learning/assessing**: with no GenAI (closed book) and with AI (open book)?
- Review **assessment formats**?
  - ◆ Paper and pencil exams
  - ◆ Digital exams with proctoring (no AI or how is the AI used)?
  - ◆ Oral examinations and video submissions
  - ◆ Design home assignments where GenAI allows to ask for more
- Prepare Master's and PhD students to **use specialised GenAI research tools** (and sensitising others to new scientific processes when relevant)

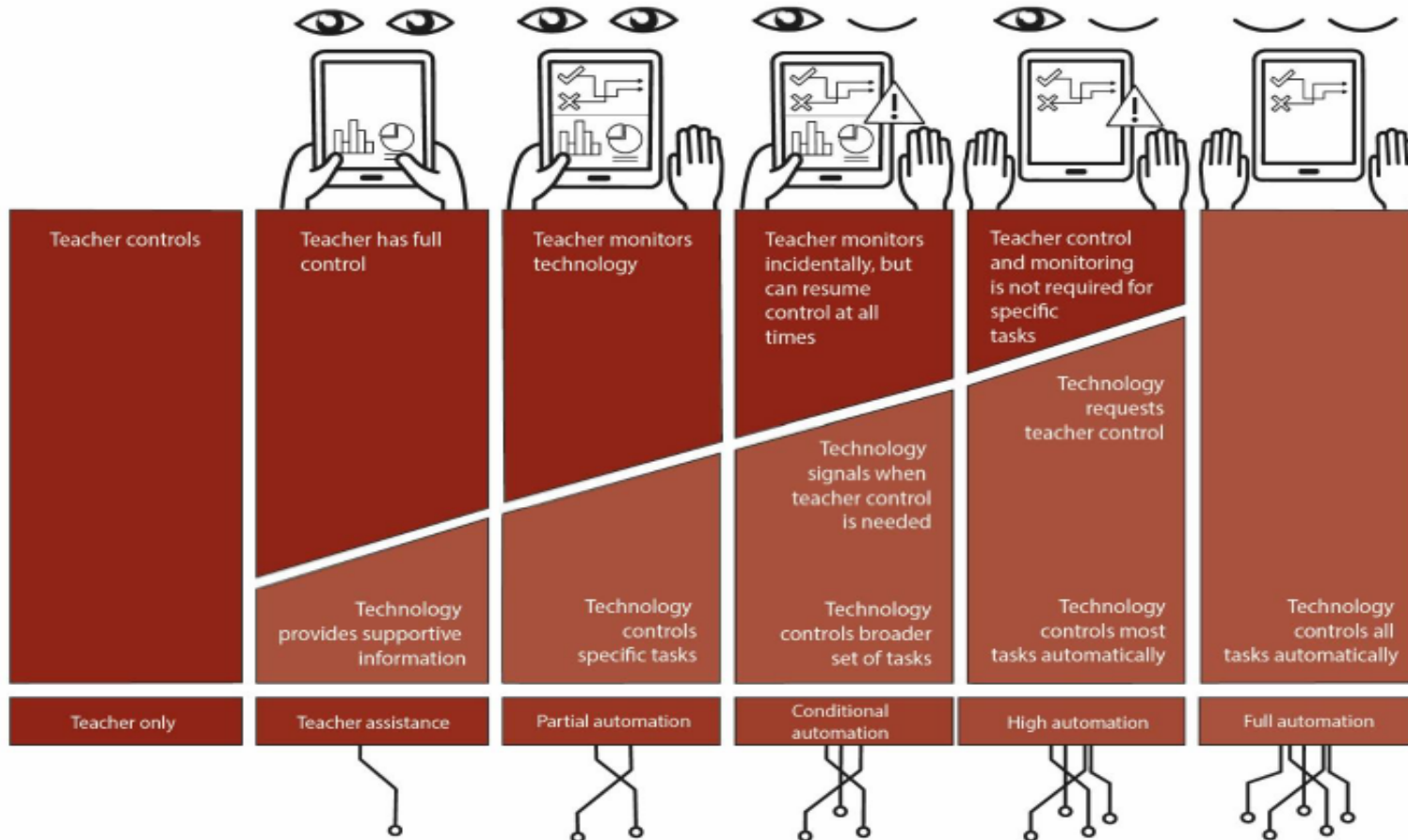


## What does this mean for HE research on AI?

- Need for more targeted research on AI and GenAI in higher education
  - ◆ **Bigger studies:** current ones do not have enough statistical power
  - ◆ Studies that do **not confuse performance at a task and learning to perform this task**
  - ◆ Studies with **longer interventions:**
    - most studies (with negative results) are based on small interventions, usually a task that is decontextualised
    - Longitudinal studies: what happens when GenAI is used repeatedly over time
  - ◆ Studies on the **use of educational GenAI tools** (rather than generic GenAI tools)
  
- Research questions
  - ◆ What are the pedagogical ways of using GenAI that lead to student learning?
  - ◆ What do the « more difficult » educational tasks that one could ask students to perform look like (so they both perform more and learn and remain manageable for teachers)?



# Where do or should educational tasks sit on human-AI automation continuum while keeping the quality, equity and safety of education?



© Anne Horvers & Inge Molenaar, Adaptive Learning Lab.

- What are the teaching and learning tasks that are ok to fully automate (or carry out with GenAI/AI)?
- What are the teaching and learning tasks for which teachers should have full control?
- What are the tasks that can be in the middle part of the continuum?
- Same questions for administration and research

# Fostering Creativity and Critical Thinking in HE



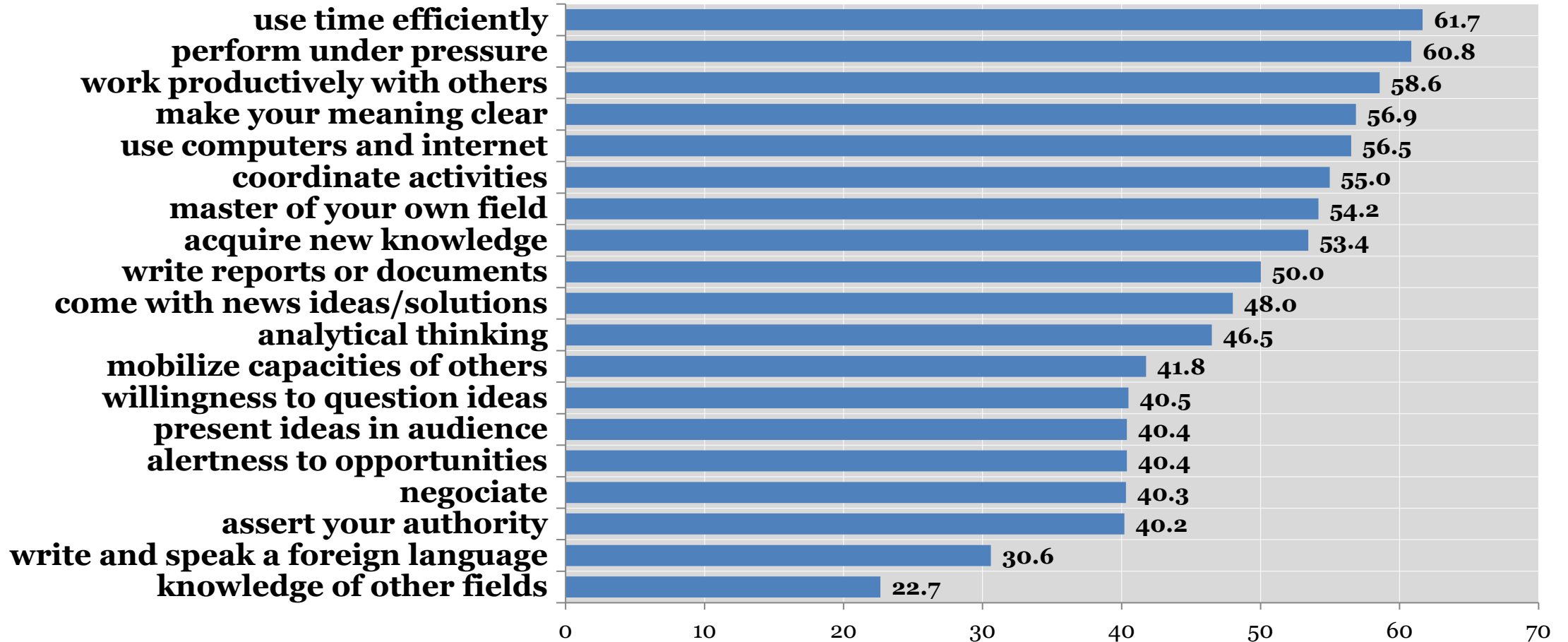


skills and education for  
innovation and digitalisation



# Skills that tertiary-educated professionals report as very important in their job

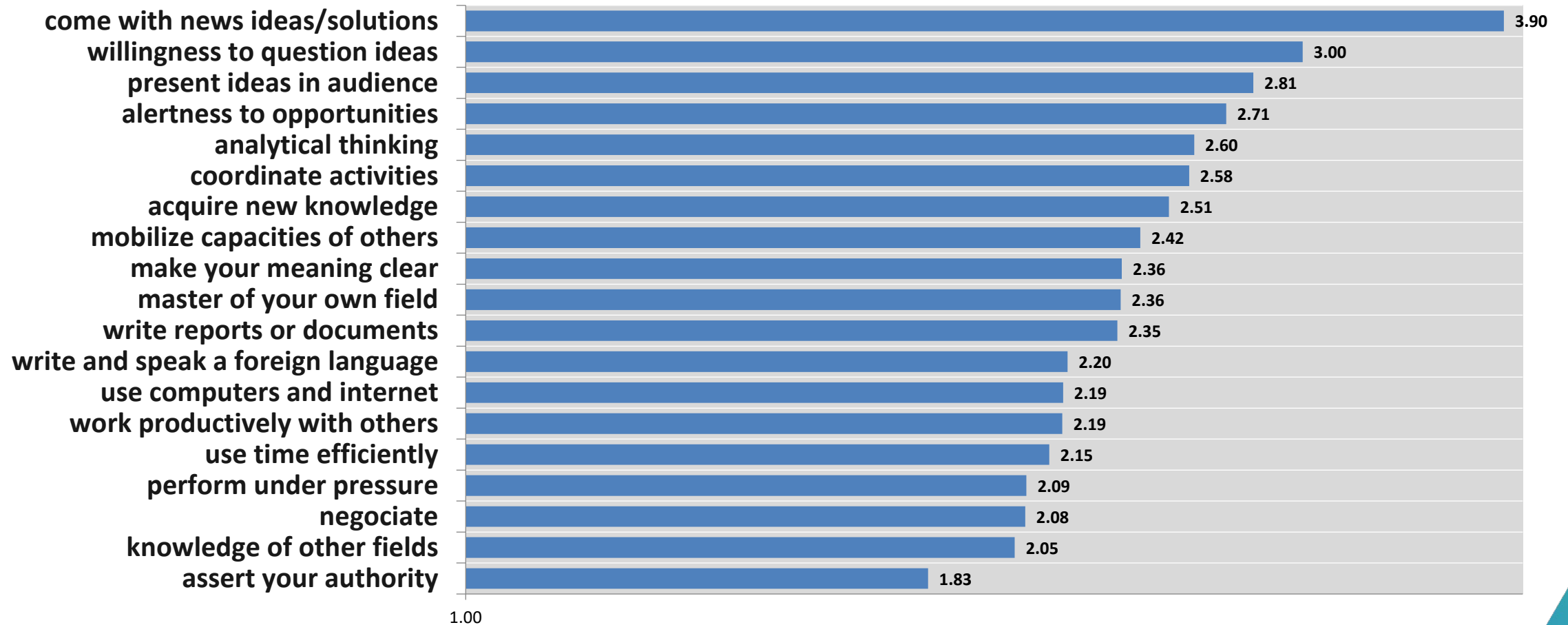
Percentage of employees reporting the following skills as very important in their job





# Critical skills for the most innovative jobs (according to tertiary-educated workers)

Likelihood (odds ratios) of reporting the following skills: people in the most innovative jobs vs. least innovative jobs









# Survey of CEOs and HRM Directors: Creativity and Innovation in top 5 Skills Demand: 2025, 2022, 2018



## Top 10 skills of 2025

-  Analytical thinking and innovation
-  Active learning and learning strategies
-  Complex problem-solving
-  Critical thinking and analysis
-  Creativity, originality and initiative
-  Leadership and social influence
-  Technology use, monitoring and control
-  Technology design and programming
-  Resilience, stress tolerance and flexibility
-  Reasoning, problem-solving and ideation

- Type of skill
-  Problem-solving
  -  Self-management
  -  Working with people
  -  Technology use and development

Source: Future of Jobs Report 2020, World Economic Forum.

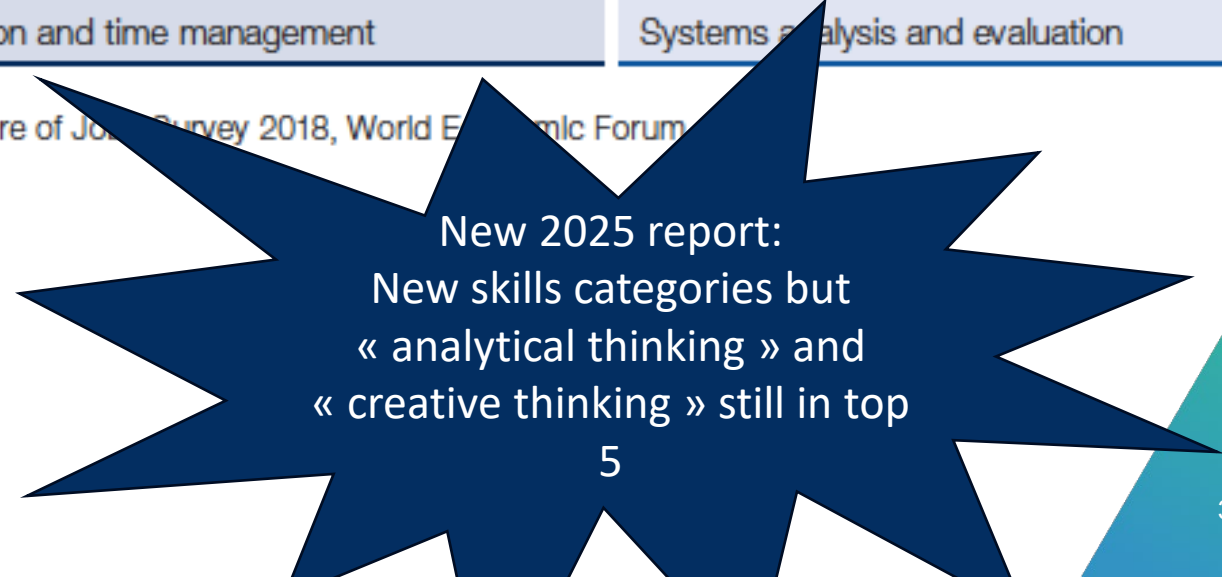
### Today, 2018

- Analytical thinking and innovation
- Complex problem-solving
- Critical thinking and analysis
- Active learning and learning strategies
- Creativity, originality and initiative
- Attention to detail, trustworthiness
- Emotional intelligence
- Reasoning, problem-solving and ideation
- Leadership and social influence
- Coordination and time management

### Trending, 2022

- Analytical thinking and innovation
- Active learning and learning strategies
- Creativity, originality and initiative
- Technology design and programming
- Critical thinking and analysis
- Complex problem-solving
- Leadership and social influence
- Emotional intelligence
- Reasoning, problem-solving and ideation
- Systems analysis and evaluation

Source: Future of Jobs Survey 2018, World Economic Forum

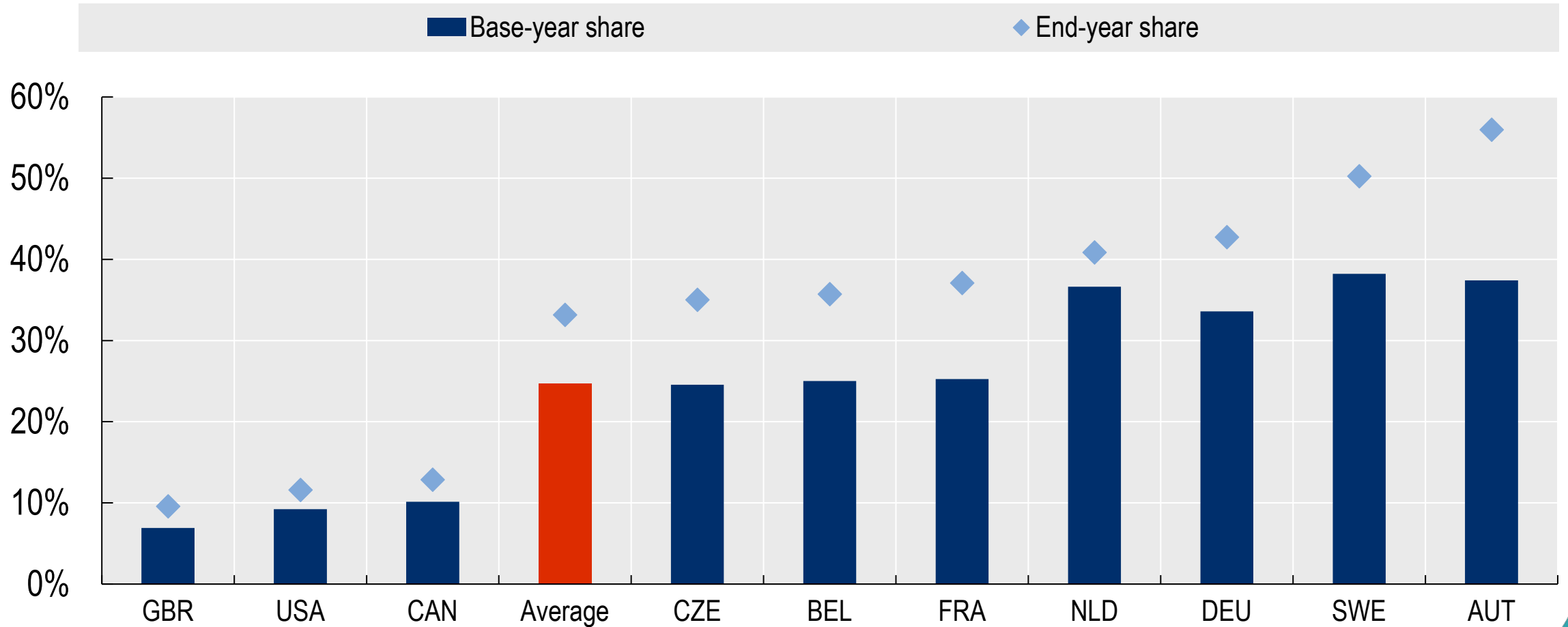


New 2025 report:  
New skills categories but  
« analytical thinking » and  
« creative thinking » still in top

5



# Evolution of demand for originality skills over the past 10 years in most AI-exposed sectors (2012 or 2018 to 2023)



Source: : Green (2024)



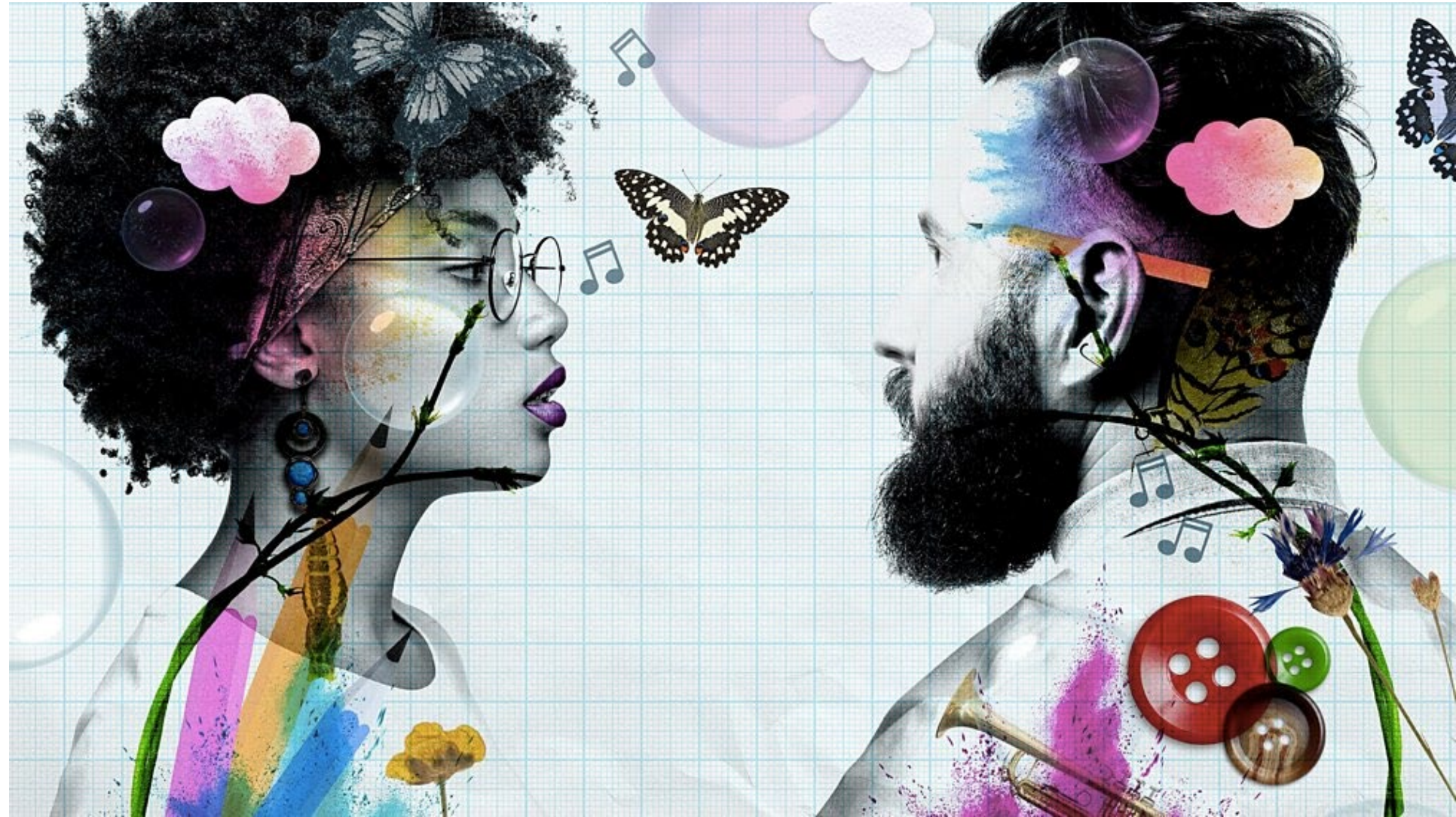
# Creativity is a source of personal and social well being / Critical thinking contributes to active citizenship and tolerance

## Creativity

- Flow
- Positive emotions
- Positive impact on health

## Critical thinking

- Scientific mindset
- Media literacy
- Openness to others' opinions
- Living with uncertainty/ambiguity
- Positive citizenship





## A means to improve the depth and quality of knowledge and develop skills for innovation

### **Creative thinking**

- More engaging (and memorable) learning
- Connection of learning with a real problem (even if fictional)
- Develops problem solving skills
- Stronger intellectual experiences

### **Critical thinking**

- Develops inquiry and evaluation skills
- Makes students weight the strength of evidence and information
- Helps students understand the nature of scientific (or other type of) knowledge
- Develops (complex) problem solving skills



# A means to make learning more engaging and valuable in the age of Generative AI?

- Students need to engage in and enjoy their learning (so they don't outsource their study to GenAI)
- Could we make education more engaging by making it closer to authentic problems?
- Could we make education more engaging by allowing personal expression in their outputs?
- Could we support them to develop the skills to evaluate the outputs of GenAI tools?

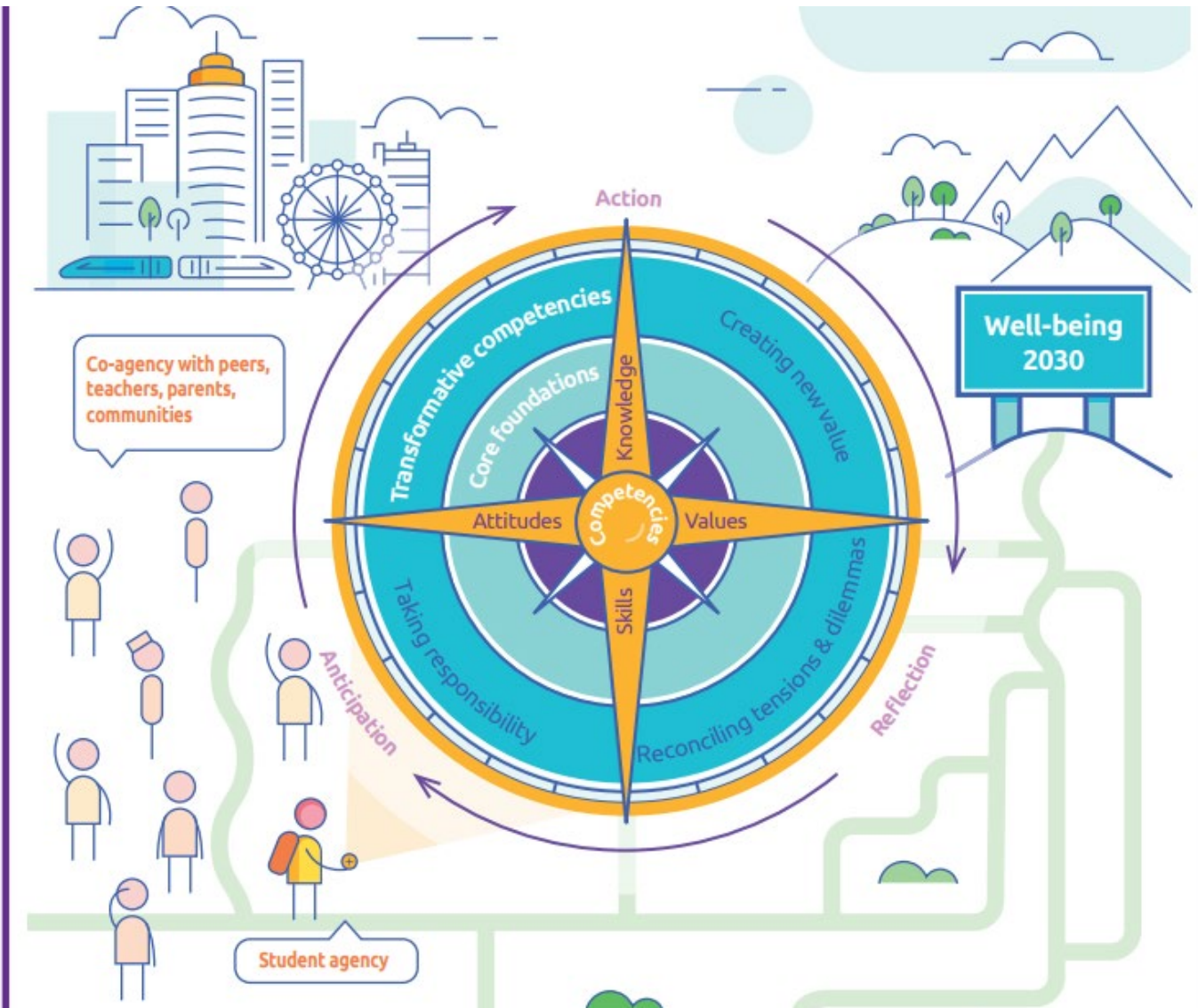




towards competency-based curricula



# OECD Learning compass



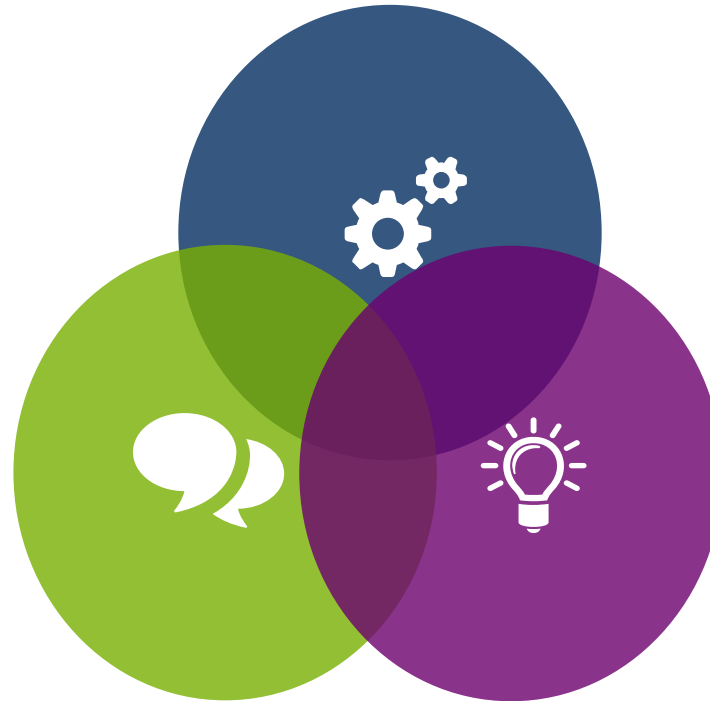
- Knowledge
- Skills
- Attitudes
- Values



# What skills should education systems foster?

## Technical skills

Know-what and know-how



## Behavioural and social skills

Self-confidence, energy, perseverance, passion, leadership, collaboration, communication

## Creativity and critical thinking skills

Creativity, critical thinking, inquiry, imagination, curiosity, ability to make connections, metacognition...





## Some comments on these skills categories



- They overlap and may reinforce each other

But

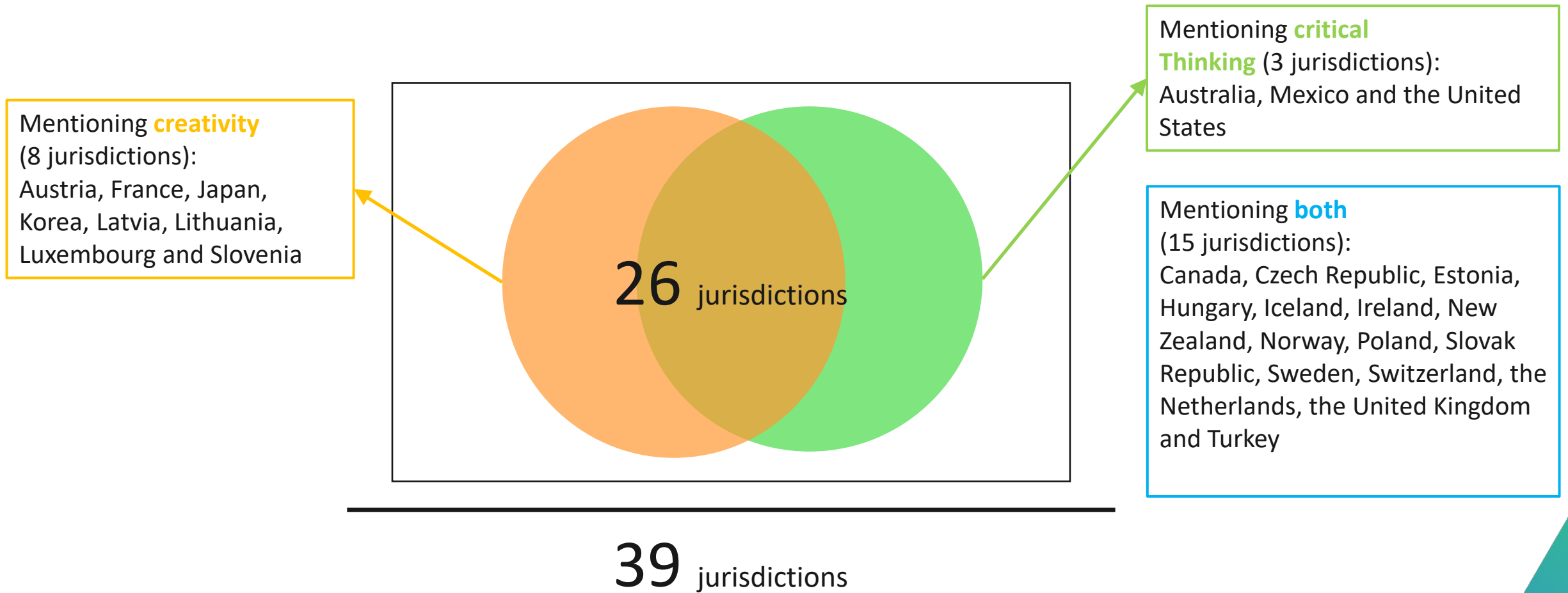
- They are different and cannot be reduced to a single skill (or measure)
- 
- They are domain-specific (take different forms in each domain)
    - ◆ Skills are generally domain-specific: one is creative in a field, one knows how to behave/communicate in a specific context, one has knowledge and problem-solving skills in a field
- 
- They can become « domain-generic »
    - ◆ A skills becomes « domain-generic » when one has gained it in a number of domains or settings, so that it becomes a « habit of mind » (a disposition or a stabilised skill) that one can apply to new fields (or when one remains at a certain level of abstraction)



# fostering and assessing creativity and critical thinking



# OECD economies set creativity and/or critical thinking high on their higher education policy agenda



\*Based on the preliminary review of the most recent higher education national strategies in 39 OECD economies. Where not available, strategies for education at all levels were reviewed.



# What the hell do we mean?





# OECD practice-engaged research project on fostering and assessing students' creativity and critical thinking

1. Articulate a common **international language** on creativity and critical thinking in education
2. Develop an exemplary **bank of pedagogical resources** to teach and assess creativity and critical thinking as part of countries' (current) curriculum
3. Develop **professional development plans**
4. Develop and pilot **evaluation instruments** to measure the effects of pedagogical practices on pedagogies, beliefs, social and behavioural skills, and standardised measures of creativity and academic achievement





# Fieldwork with network of 26 higher education institutions from 14 countries: 5 semesters involving 360 HE faculty and 10 400 students

Building an international community of practice of institutions around teaching, learning and assessing creativity and critical thinking

**Australia:** Monash University

**Canada:** McGill University, Ontario Tech University

**China:** Central China Normal University, North East Normal University, Shanghai Normal University

**Denmark:** University College Copenhagen X 6

**Finland:** Aalto University

**Italy:** Politecnico di Torino

**Ireland:** University of Limerick (NISE)

**Japan:** International Christian University, Sophia University

**Korea:** 2 institutions coordinated by KEDI

**Mexico:** University of Guadalajara, National Pedagogical University

**Portugal:** ESSSM, IPVC, U. Aveiro, U. Lisbon (IST), U. Porto, ULHT, UTAD

**[Russian Federation: HSE Moscow]**

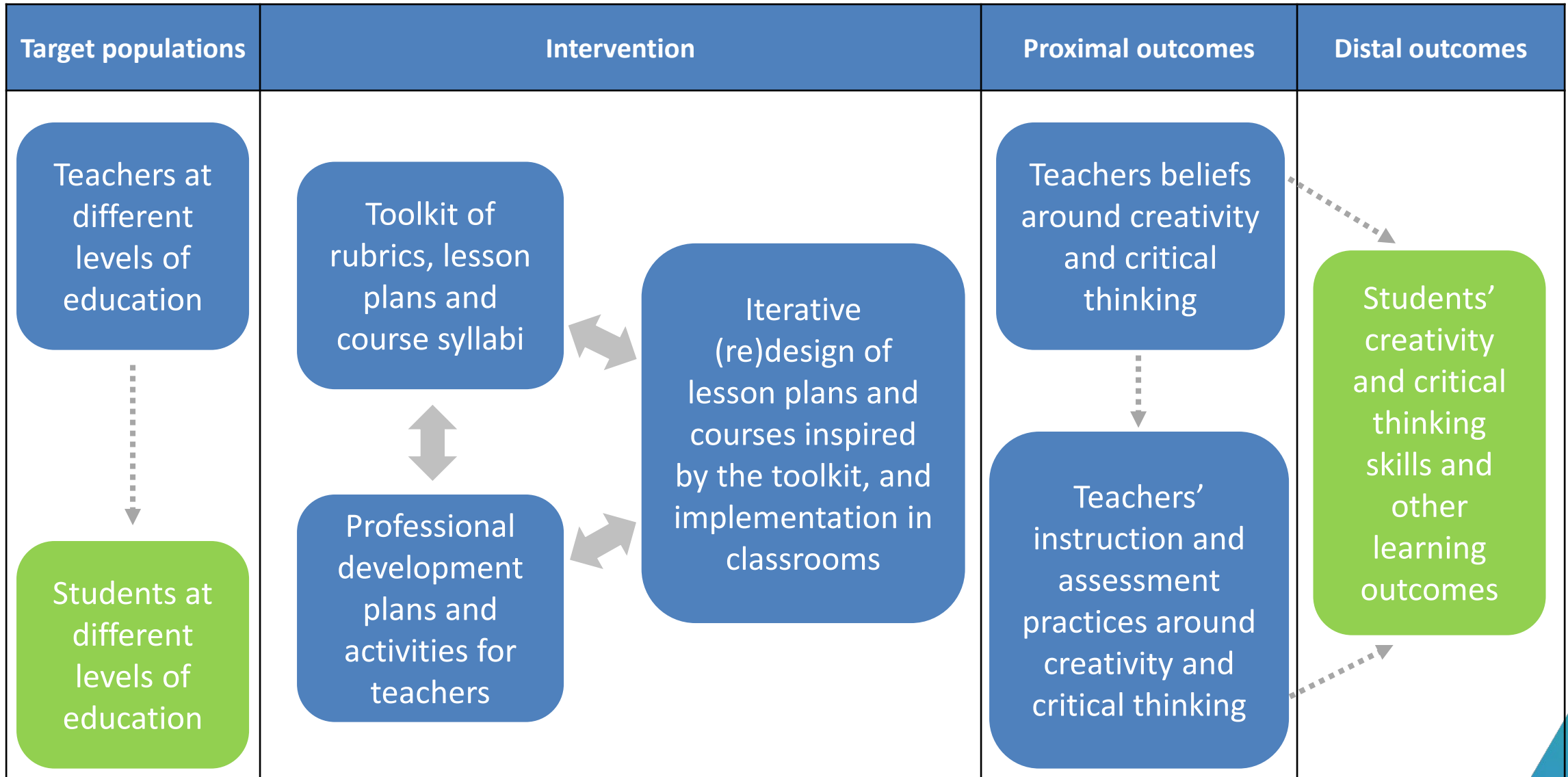
**Spain:** University Camilo José Cela

**United Kingdom (England):** University of Winchester





# First OECD experimental practice-engaged project: Theory of action / Logical model





building a professional representation  
through a bank of pedagogical resources

# Creativity

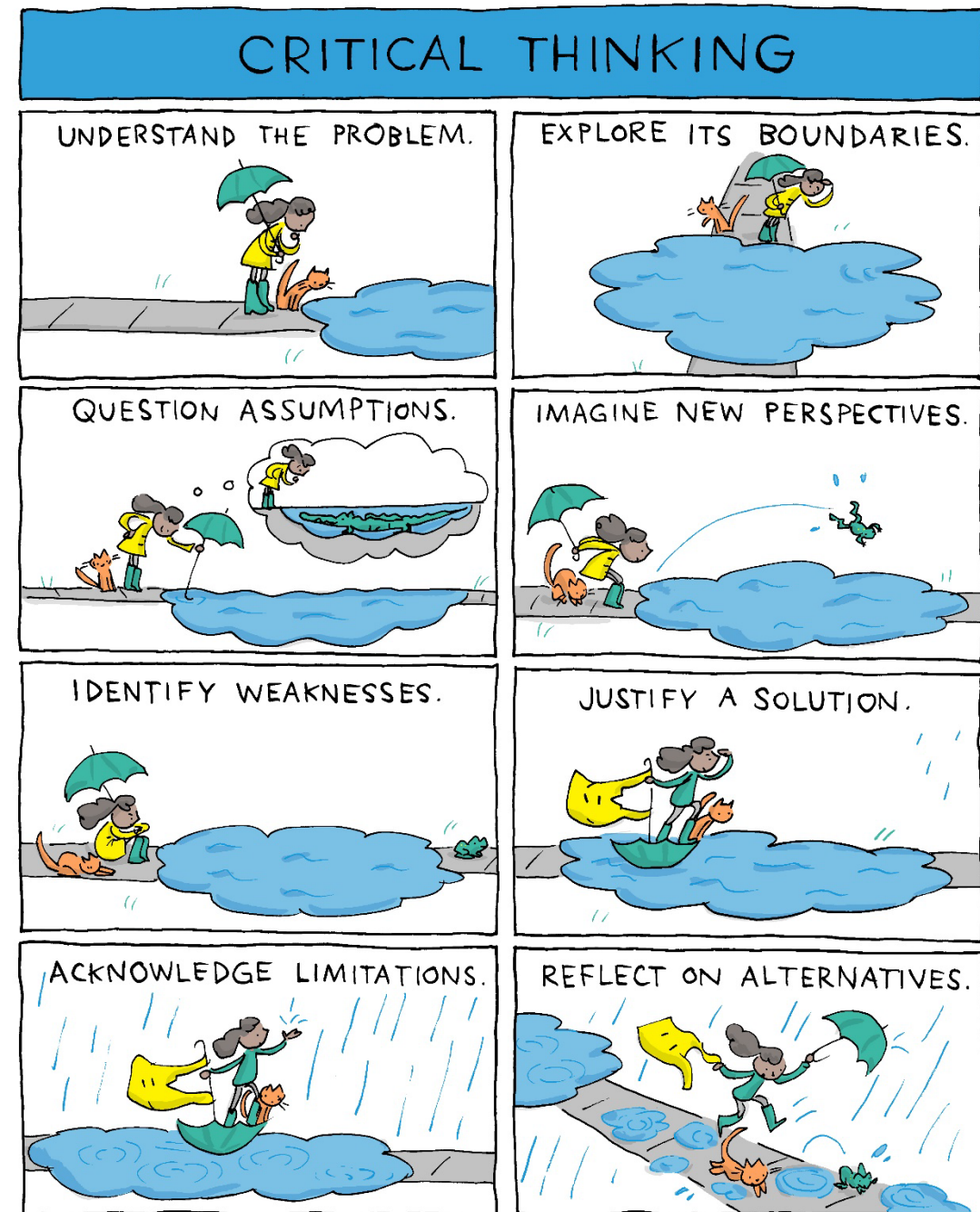
- **Creativity:** the ability to produce work that is both novel and appropriate
- It is about:
  - ◆ Ideation and exploration (divergent-exploratory)
  - ◆ New and interesting combinations (convergent-integrative)
  - ◆ Getting at ease with unusual and daring ideas
  - ◆ Not about « novel to the world » or « gifted » or « successful »





# Critical thinking

- **Critical thinking:** the ability to carefully evaluate and judge statements, ideas and theories relative to alternative explanations or solutions so as to reach a competent, independent position
- It is about:
  - ◆ Thinking rationally (slow) and in a certain disciplinary frame
  - ◆ Understanding the limitations of theories and conventions (including ours)
  - ◆ Challenging assumptions
  - ◆ Considering other theories and perspectives (possibly to then discard them)





# Bank of pedagogical resources by/for teachers



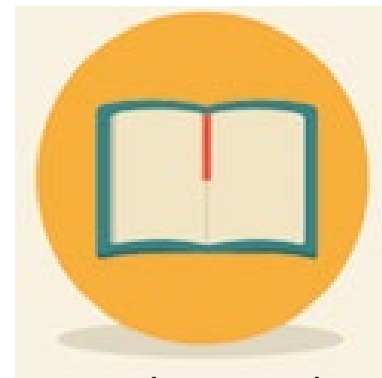
Rubrics



Lesson plans



Assessments



Student work



## Bank of pedagogical resources by/for teachers



### Rubrics

- To **develop** activities
- To **improve** activities
- To **assess** student work
- To **understand** and develop awareness of creativity and critical thinking



# OECD (conceptual) rubric on creativity and critical thinking (class-friendly version)

	<b>CREATIVITY</b> Coming up with ideas and solutions	<b>CRITICAL THINKING</b> Questioning and evaluating ideas and solutions
<b>INQUIRING</b>	Make connections to other concepts and knowledge from the same or from other disciplines	Identify and question assumptions and generally accepted ideas or practices
<b>IMAGINING</b>	Generate and play with unusual and radical ideas	Consider several perspectives on a problem based on different assumptions
<b>DOING</b>	Produce, perform or envision a meaningful output that is personally novel	Explain both strengths and limitations of a product, a solution or a theory justified on logical, ethical or aesthetic criteria
<b>REFLECTING</b>	Reflect on the novelty of solution and of its possible consequences	Reflect on the chosen solution/position relative to possible alternatives



# OECD rubric on creativity and critical thinking (comprehensive version)

	<b>CREATIVITY</b> Coming up with ideas and solutions	<b>CRITICAL THINKING</b> Questioning and evaluating ideas and solutions
<b>INQUIRING</b>	<ul style="list-style-type: none"><li>• Feel, empathise, observe, describe relevant experience and information</li><li>• Make connections, integrate other disciplinary perspectives</li></ul>	<ul style="list-style-type: none"><li>• Understand context/frame and boundaries of the problem</li><li>• Challenge assumptions, check accuracy, analyse gaps in knowledge</li></ul>
<b>IMAGINING</b>	<ul style="list-style-type: none"><li>• Explore, seek and generate ideas</li><li>• Stretch and play with unusual/risky/radical ideas</li></ul>	<ul style="list-style-type: none"><li>• Review alternative theories and opinions and compare/find perspectives on the problem</li><li>• Identify strengths and weaknesses of evidence, arguments, claims and beliefs</li></ul>
<b>DOING</b>	<ul style="list-style-type: none"><li>• Envision, Express, Produce, Prototype new product / solution / performance</li></ul>	<ul style="list-style-type: none"><li>• Appraise / Base / Justify opinion/products on logical, ethical or aesthetic criteria/reasoning</li></ul>
<b>REFLECTING</b>	<ul style="list-style-type: none"><li>• Assess the novelty of solution and/or possible consequences</li></ul>	<ul style="list-style-type: none"><li>• Acknowledge uncertainty/limits of endorsed opinion/solution and reflect on own perspective / bias</li></ul>

# A series of domain-specific versions

OECD CONCEPTUAL RUBRIC

CLASS-FRIENDLY RUBRIC

**MUSIC**

CREATIVITY & CRITICAL THINKING

This rubric identifies the main subskills related to creativity and critical thinking that students should develop as part of their education. It can be used to reflect on existing teaching practices and design new activities to better fit specific contexts. Teachers/faculty can discuss it with students to build understanding of creativity and critical thinking and ensure these skills are learned explicitly. It is not meant to score students but rather to provide them with a continuum of skill progression.

This rubric was developed by the OECD for the project assessing creativity and critical thinking skills. It is available under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 IGO licence (CC BY-NC-SA 3.0 IGO).

OECD

OECD CONCEPTUAL RUBRIC

**MUSIC**

CLASS-FRIENDLY RUBRIC

**CREATIVITY**  
Coming up with new ideas and solutions

**CRITICAL THINKING**  
Questioning and evaluating ideas and solutions

<b>INQUIRING</b>	Make connections to other musical styles, concepts or conceptual ideas in other disciplines	Identify and question assumptions and conventional rules in a musical performance, composition or analysis
<b>IMAGINING</b>	Play with unusual and radical ideas when preparing to perform, compose, orchestrate, or analyse a music piece	Consider several perspectives on a musical performance, composition, interpretation or analysis
<b>DOING</b>	Perform, compose, or analyse music with expressive qualities or relating to personally meaningful subject matter	Explain both strengths and limitations of a performance, a composition or an analysis of a music piece
<b>REFLECTING</b>	Reflect on steps taken to create performances, compositions or analyses of a music piece	Reflect on the chosen way of performing, composing or analysing a music piece relative to possible alternatives

OECD CONCEPTUAL RUBRIC

**SCIENCE**

CLASS-FRIENDLY RUBRIC

**CREATIVITY**  
Coming up with new ideas and solutions

**CRITICAL THINKING**  
Questioning and evaluating ideas and solutions

<b>INQUIRING</b>	Make connections to other scientific concepts or conceptual ideas in other disciplines	Identify and question assumptions and generally accepted ideas of a scientific explanation or approach to a problem
<b>IMAGINING</b>	Generate and play with unusual and radical ideas when approaching or solving a scientific problem	Consider several perspectives on a scientific problem
<b>DOING</b>	Pose and propose how to solve a scientific problem in a personally novel way	Explain both strengths and limitations of a scientific solution based on logical and possibly other criteria (practical, ethical, etc.)
<b>REFLECTING</b>	Reflect on steps taken to pose and solve a scientific problem	Reflect on the chosen scientific approach or solution relative to possible alternatives

OECD CONCEPTUAL RUBRIC

CLASS-FRIENDLY RUBRIC

**SCIENCE**

CREATIVITY & CRITICAL THINKING

This rubric identifies the main subskills related to creativity and critical thinking that students should develop as part of their science education. It can be used to reflect on existing teaching practices and design new activities to better fit specific contexts. Teachers/faculty can discuss it with students to build understanding of creativity and critical thinking and ensure these skills are learned explicitly. It is not meant to score students but rather to provide them with a continuum of skill progression.

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OECD



# Bank of pedagogical resources: examples of lesson plans / syllabi



## My region: past(s) and future(s)

**Grade 8** Interdisciplinary  
(History, and Visual Arts or Science)

This activity uses History as a frame for investigating artistic manifestations and/or scientific phenomena. Students explore a past historical period in their region and the art and/or technology of the time, focusing then on a particular historical event which led to changes in the artistic field and/or technology. Students are then invited to question these ideas by imagining alternative realities for their region outside the actual historical continuity (i.e. 'counterfactuals', had the event not happened) and come up with artworks or technological solutions that would exist in these alternative courses of history. The exercise leads to a projection in the future, with students proposing ideas and solutions for promoting desired changes in their region.

**Suggested time allocation** About 4 lesson periods

**Subject-specific skills** This activity is designed as interdisciplinary and teachers will have flexibility to decide about the specific content and skills it addresses besides knowledge and understanding of History



## Lesson plans

- **100+ examples** of lesson plans in K-12
- **30+ course examples** in HE
- **To illustrate** how to deliver curriculum contents while developing creativity and critical thinking
- **To inspire and improve**
- **Most are anchored** in a discipline

### INFECTIOUS DISEASES I

Integrated Master in Veterinary Medicine

4<sup>th</sup> Year; 1<sup>st</sup> semester

Typical theoretical size: 80-100 students

### EDUCATIONAL PSYCHOLOGY

Degree/Study programme

Year within programme

Teacher education

2

#### COURSE DESCRIPTION

This 15-week course aims to provide students with a solid foundation in veterinary medicine. Students will explore the epidemiological features of selected infectious diseases in different animals. They will be able to...

#### COURSE DESCRIPTION

This course engages students in an exploration of the psychological processes that influence human behavior and how people behave in educational contexts. Students will explore cognitive, constructivist, and humanist theories of learning.

### PHILOSOPHY OF SCIENCE

Degree/Study programme

Year within programme

Typical class size

40

#### COURSE DESCRIPTION

This course serves as an introduction to the philosophy of science. It helps students develop their creativity in discussing the relationship between science and other disciplines. The course covers the demarcation problem, the classification of scientific theories, and the philosophy of science.

### Operations Research

2<sup>nd</sup> cycle in Informatics Engineering

1<sup>st</sup> year; 1<sup>st</sup> semester

Typical theoretical size: 1 instructor

Typical theoretical size: 1 instructor

#### COURSE DESCRIPTION

This 15-week course intends to introduce students to the broad field of Operations Research (OR); it prepares students for modelling and solving real-world problems as production planning, resource management and distribution, using mathematical models and models with network structure.

#### PREREQUISITES

None

#### LEARNING OUTCOMES

Upon successful completion of the course, students will be able to:

The components of the course include: an introduction to the original linear programming (LP) modelling; presenting the main concepts and results in LP and some LP problem-solving methods, such as the graphical method and the simplex method, as well as the dual simplex method; the economic interpretation of the optimal solution; both post-optimal and sensitivity analysis to different perturbations; the fundamental concepts of graphs and networks; the study of spanning tree, shortest path, maximum flow and minimum cost flow problems; and the use of computational resources.



# Animal Welfare and Society: Example of course unit

## WEEK 9: Farm/zoo trip and producing animal welfare indicators

### Learning objectives:

#### Technical skills

- To practice application of animal welfare assessment frameworks.
- To apply knowledge and develop frameworks of welfare assessment in a given species.
- To explore and evaluate real world applications of welfare assessment
- To collect data for Assignment 2 (an individual field observation and welfare assessment).

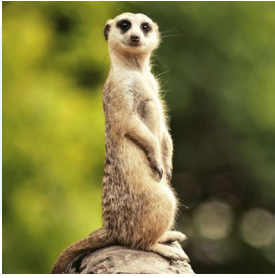
### Learning objectives:

#### Creativity and/or Critical thinking

- Critical thinking:
  - Identify and analyse gaps in knowledge before designing a welfare assessment.
  - Understand the limitations of theories and assessment frameworks in detail.
  - Justify the inclusion and exclusion of particular welfare indicators in assessment frameworks.
  - Reflect on own perception and that of others
- Creativity:
  - Design and prototype new assessment frameworks.
  - Generate and play with ideas regarding what indicators to include/exclude and make connections between inclusion/exclusion and overall validity of the assessment framework.



## Animal Welfare and Society: Example



1. Students prepare by independently researching the natural history of meerkats and reminding themselves of the work of previous weeks on **animal welfare assessment frameworks** and the bases on which indicators can be created, including stress, pain, suffering, and positive welfare states.
2. Each group works together to **develop a welfare assessment of meerkats**, starting from one of three assessment frameworks studied previously (Five Freedoms, Five Domains, Qualitative Behaviour Assessment) as the skeleton. They have to come up with a set of indicators that are novel but appropriate in addressing potential limitations of the frameworks they know. They generate and decide on ideas for **alternative welfare indicators and scoring methods**.
3. All three groups meet to **review and explain their choice of indicators** and compare/contrast welfare outcomes across different assessment methods.
  - ◆ Students provide peer feedback on where the novelty lies in each group's indicators and the implications for assessment outcomes
  - ◆ Each group's application and any inconsistencies are discussed to determine likely causes of variation and to acknowledge limitations



# Reflecting on one's courses: when do I provide opportunities to my students to develop what skills?

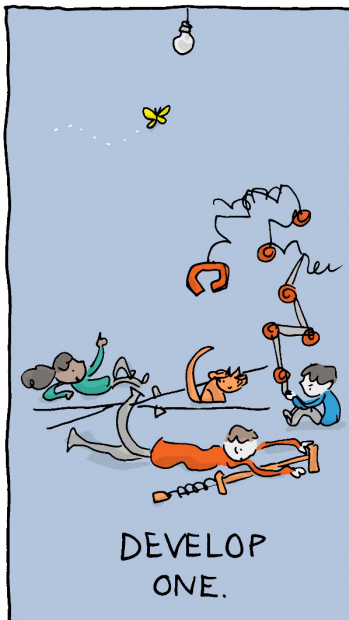
## Mapping of the lesson plan to the OECD rubric

	<b>CREATIVITY</b> Coming up with new ideas and solutions	Steps	<b>CRITICAL THINKING</b> Questioning and evaluating ideas and solutions	Steps
<b>INQUIRING</b>	Make connections to other scientific concepts or conceptual ideas in other disciplines	2,5	Identify and question assumptions and generally accepted ideas of a scientific explanation or approach to a problem	1,7
<b>IMAGINING</b>	Generate and play with unusual and radical ideas when approaching or solving a scientific problem	1,4,7	Consider several perspectives on a scientific problem	3-6
<b>DOING</b>	Pose and propose how to solve a scientific problem in a personally novel way	1,7	Explain both strengths and limitations of a scientific solution based on logical and possibly other criteria (practical, ethical, etc.)	6,7
<b>REFLECTING</b>	Reflect on steps taken to pose and solve a scientific problem	7	Reflect on the chosen scientific approach or solution relative to possible alternatives	2,3,4,7

# TEACHING CREATIVITY/CRITICAL THINKING

## 8 Design criteria for good lessons

1. Create students' **need/interest to learn**
2. Be **challenging**
3. **Develop clear technical knowledge** in one domain or more
4. Include the **development of a "product"**



## TEACHING CREATIVITY/CRITICAL THINKING

### 8 Design criteria for good courses



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5. Have **students co-design part of the product/solution or problem**
6. Deal with **problems that can be looked at from different perspectives**
7. Leave **room for the unexpected**
8. Include **space and time for students to reflect and give/receive feedback**



# Bank of pedagogical resources by/for teachers/professors



Assessments

- Examples of **assignments**
- Examples of **exam questions**
- **Scoring rubrics**
- Scoring rubrics for professional development
- Development of a **standardised test** for undergraduate students (upcoming)

# Assessment rubrics that articulate levels of progression

OECD ASSESSMENT RUBRIC

## CREATIVITY

**PROCESS** **PRODUCT**

<p><b>4</b></p> <p><b>OUTSTANDING</b></p>	<p><b>THE STUDENT WORK:</b></p> <ul style="list-style-type: none"> <li>considers several ways of formulating and answering a problem,</li> <li>challenges several common positions or ideas about the problem</li> <li>shows a clear understanding of the strength and limitations of the chosen and alternative positions.</li> <li>shows an openness to the ideas, critiques or feedback of others when relevant.</li> </ul>	<p><b>THE STUDENT WORK:</b></p> <ul style="list-style-type: none"> <li>presents a specific personal position to a clearly formulated problem,</li> <li>relates this position to alternative theories or perspectives within or outside the discipline,</li> <li>justifies the position with good evidence,</li> <li>acknowledges the assumptions and limitations of the chosen position.</li> </ul>
<p><b>3</b></p> <p><b>FLOURISHING</b></p>	<p><b>THE STUDENT WORK:</b></p> <ul style="list-style-type: none"> <li>Considers one other way to formulate and answer the problem,</li> <li>challenges one common position or idea about the problem</li> <li>shows a clear understanding of the strength and limitations of the chosen and the alternative positions.</li> </ul>	<p><b>THE STUDENT WORK:</b></p> <ul style="list-style-type: none"> <li>presents a personal position to a clearly formulated problem,</li> <li>relates this position to one alternative theory or perspective within or outside the discipline,</li> <li>justifies the position with some evidence, and</li> <li>acknowledges the assumptions of the chosen position.</li> </ul>
<p><b>2</b></p> <p><b>EMERGENT</b></p>	<p><b>THE STUDENT WORK:</b></p> <ul style="list-style-type: none"> <li>shows the willingness to go beyond one's initial way to formulate and answer the problem, but</li> <li>does not clearly identify the assumptions of the examined theories or practices or their strengths and weaknesses.</li> </ul>	<p><b>THE STUDENT WORK:</b></p> <ul style="list-style-type: none"> <li>presents a position to a problem that is not clearly formulated,</li> <li>relates this position to one alternative theory or perspective within the discipline,</li> <li>provides little evidence or acknowledge only minimally the assumptions and limitations of the chosen position.</li> </ul>
<p><b>1</b></p> <p><b>DORMANT</b></p>	<p><b>THE STUDENT WORK:</b></p> <ul style="list-style-type: none"> <li>shows little willingness to explore other positions or theories than the most commonly accepted one and</li> <li>shows no willingness to question the assumptions of the chosen position, theory or practices.</li> </ul>	<p><b>THE STUDENT WORK:</b></p> <ul style="list-style-type: none"> <li>presents a commonly accepted position to a problem,</li> <li>justifies it with sound evidence, but</li> <li>fails to question its assumptions or consider other possible perspectives on the problem.</li> </ul>

OECD ASSESSMENT RUBRIC

## CRITICAL THINKING

**PROCESS** **PRODUCT**

<p><b>4</b></p> <p><b>OUTSTANDING</b></p>	<p><b>THE STUDENT WORK:</b></p> <ul style="list-style-type: none"> <li>considers several ways of formulating and answering a problem,</li> <li>challenges several common positions or ideas about the problem</li> <li>shows a clear understanding of the strength and limitations of the chosen and alternative positions.</li> <li>shows an openness to the ideas, critiques or feedback of others when relevant.</li> </ul>	<p><b>THE STUDENT WORK:</b></p> <ul style="list-style-type: none"> <li>presents a specific personal position to a clearly formulated problem,</li> <li>relates this position to alternative theories or perspectives within or outside the discipline,</li> <li>justifies the position with good evidence,</li> <li>acknowledges the assumptions and limitations of the chosen position.</li> </ul>
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# OECD assessment rubric on critical thinking (for teacher formative and summative assessment): product and process dimensions

□	Level-4 Outstanding□	Level-3 Excellent□	Level-2 Emergent□	Level-1 Dormant□
Product□	<p>¶ The student work ¶</p> <ul style="list-style-type: none"> <li>• → presents a specific personal position to a clearly formulated problem, ¶</li> <li>• → relates this position to alternative theories or perspectives within or outside the discipline, ¶</li> <li>• → justifies the position with good evidence, ¶</li> <li>• → acknowledges the assumptions and limitations of the chosen position. ¶</li> </ul> <p>□</p>	<p>¶ The student work ¶</p> <ul style="list-style-type: none"> <li>• → presents a personal position to a clearly formulated problem, ¶</li> <li>• → relates this position to one alternative theory or perspective within or outside the discipline, ¶</li> <li>• → justifies the position with some evidence, and ¶</li> <li>• → acknowledges the assumptions of the chosen position. ¶</li> </ul> <p>□</p>	<p>¶ The student work ¶</p> <ul style="list-style-type: none"> <li>• → presents a position to a problem that is not clearly formulated, ¶</li> <li>• → relates this position to one alternative theory or perspective within the discipline, ¶</li> <li>• → provides little evidence or acknowledge only minimally the assumptions and limitations of the chosen position. □</li> </ul>	<p>¶ The student work ¶</p> <ul style="list-style-type: none"> <li>• → presents a commonly accepted position to a problem, ¶</li> <li>• → justifies it with sound evidence, but ¶</li> <li>• → fails to question its assumptions or consider other possible perspectives on the problem. □</li> </ul>
Process□	<p>¶ The work process ¶</p> <ul style="list-style-type: none"> <li>• → considers several ways of formulating and answering a problem, ¶</li> <li>• → challenges several common positions or ideas about the problem ¶</li> <li>• → shows a clear understanding of the strength and limitations of the chosen and alternative positions. ¶</li> <li>• → shows an openness to the ideas, critiques or feedback of others when relevant. □</li> </ul>	<p>¶ The work process ¶</p> <ul style="list-style-type: none"> <li>• → considers one other way to formulate and answer the problem, ¶</li> <li>• → challenges one common position or idea about the problem ¶</li> <li>• → shows a clear understanding of the strength and limitations of the chosen and the alternative positions. □</li> </ul>	<p>¶ The work process ¶</p> <ul style="list-style-type: none"> <li>• → shows the willingness to go beyond one's initial way to formulate and answer the problem, but ¶</li> <li>• → does not clearly identify the assumptions of the examined theories or practices or their strengths and weaknesses. □</li> </ul>	<p>¶ The work process ¶</p> <ul style="list-style-type: none"> <li>• → shows little willingness to explore other positions or theories than the most commonly accepted one and ¶</li> <li>• → shows no willingness to question the assumptions of the chosen position, theory or practices. □</li> </ul>



# Combined version of assessment rubric for formative/summative purposes

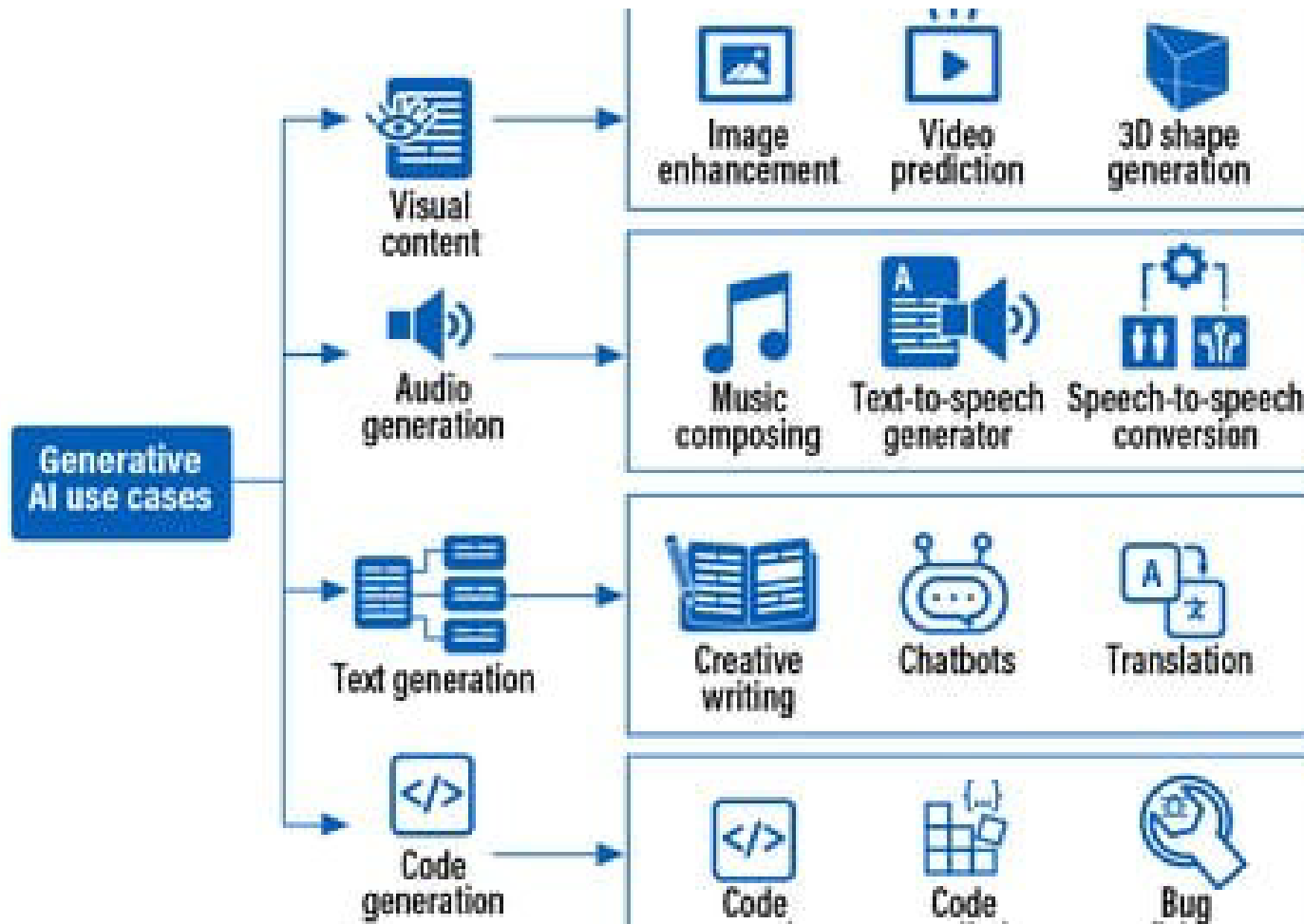
	<b>4 Outstanding</b>	<b>3 Flourishing</b>	<b>2 Emergent</b>	<b>1 Dormant</b>
Content knowledge	Describe criteria	Describe criteria	Describe criteria	Describe criteria
Procedural knowledge	Describe criteria	Describe criteria	Describe criteria	Describe criteria
Critical Thinking	Describe criteria	Describe criteria	Describe criteria	Describe criteria
Creativity	Describe criteria	Describe criteria	Describe criteria	Describe criteria
Communication	Describe criteria	Describe criteria	Describe criteria	Describe criteria



# AI, Creativity and Critical thinking

# ➤ Possibilities to do things you couldn't (easily) do before

## Generative AI



### New possibilities for learning:

- Brainstorming
- Feedback
- Translation
- Generation of first sketches
- Synthesis
- Copy-editing and editing

### New challenges for learning too:

Different challenges for different levels of education and expertise

# ➤ Possibilities to do things you couldn't (easily) do before



Loops						Name	Tempo	Key	Beats	Fav
Reset	Drums	Piano	Rock/Blues	Single	Ensemble	Atmospheric Lead	95	G	8	<input checked="" type="checkbox"/>
Favorites	Drum Kit	Elec Piano	Urban	Clean	Distorted	Dreamy Guitar	115	E	8	<input type="checkbox"/>
Bass	Beats	Organ	World	Acoustic	Electric	Fingerstyle Line	120	A	4	<input type="checkbox"/>
Guitars	Percussion	Synths	Electronic	Relaxed	Intense	Funky Wah	95	D	16	<input checked="" type="checkbox"/>
Strings	Shaker	Horn	Country	Cheerful	Dark	Muted Electric	90	A	8	<input type="checkbox"/>
						Southern Rock Riff	112	C	16	<input type="checkbox"/>
						Textural Electric	115	D	8	<input checked="" type="checkbox"/>
						Vintage Guitar	125	D	16	<input type="checkbox"/>

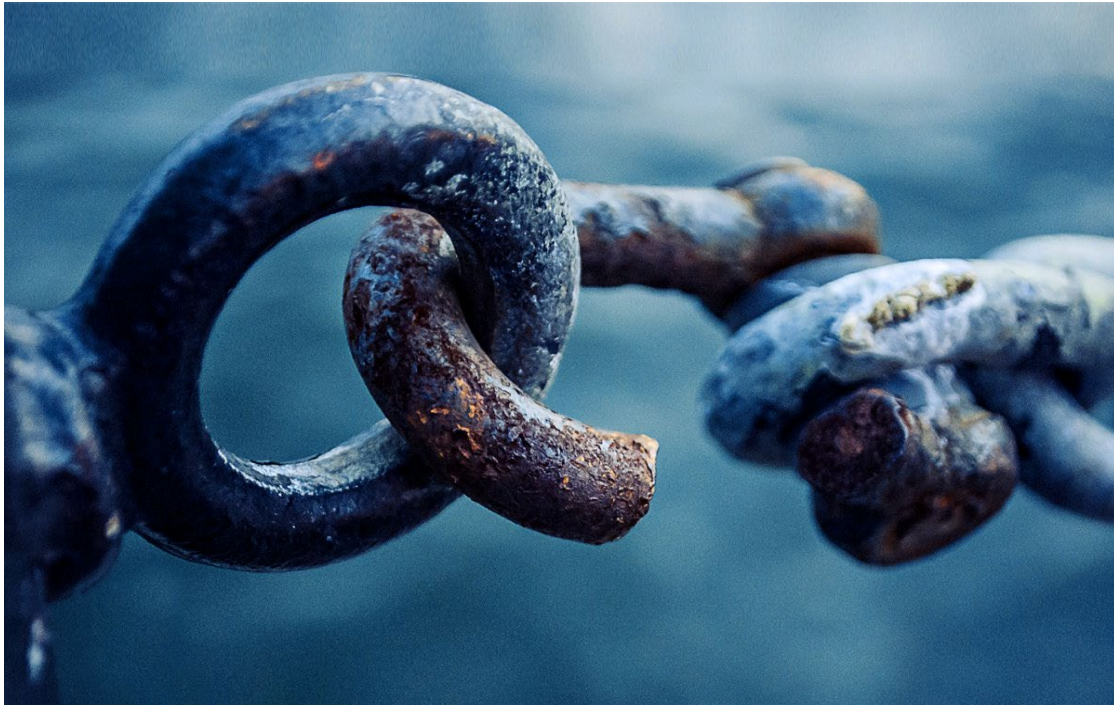


# 10 pointers to support change and improvement towards creative higher education

1. Be explicit in your education strategy
2. Define what you are talking about
3. Create alignment and incentives at all levels of education (admission)
4. Integrate it in the regular disciplinary teaching
5. Make it part of formal assessments and evaluations
6. Make sure faculty leadership support it and instructors feel authorised
7. Provide faculty members with professional learning opportunities
8. Provide faculty members with scaffolding tools and exemplars
9. Create and support international and domestic communities of practice
10. Monitor and evaluate the effects and impacts



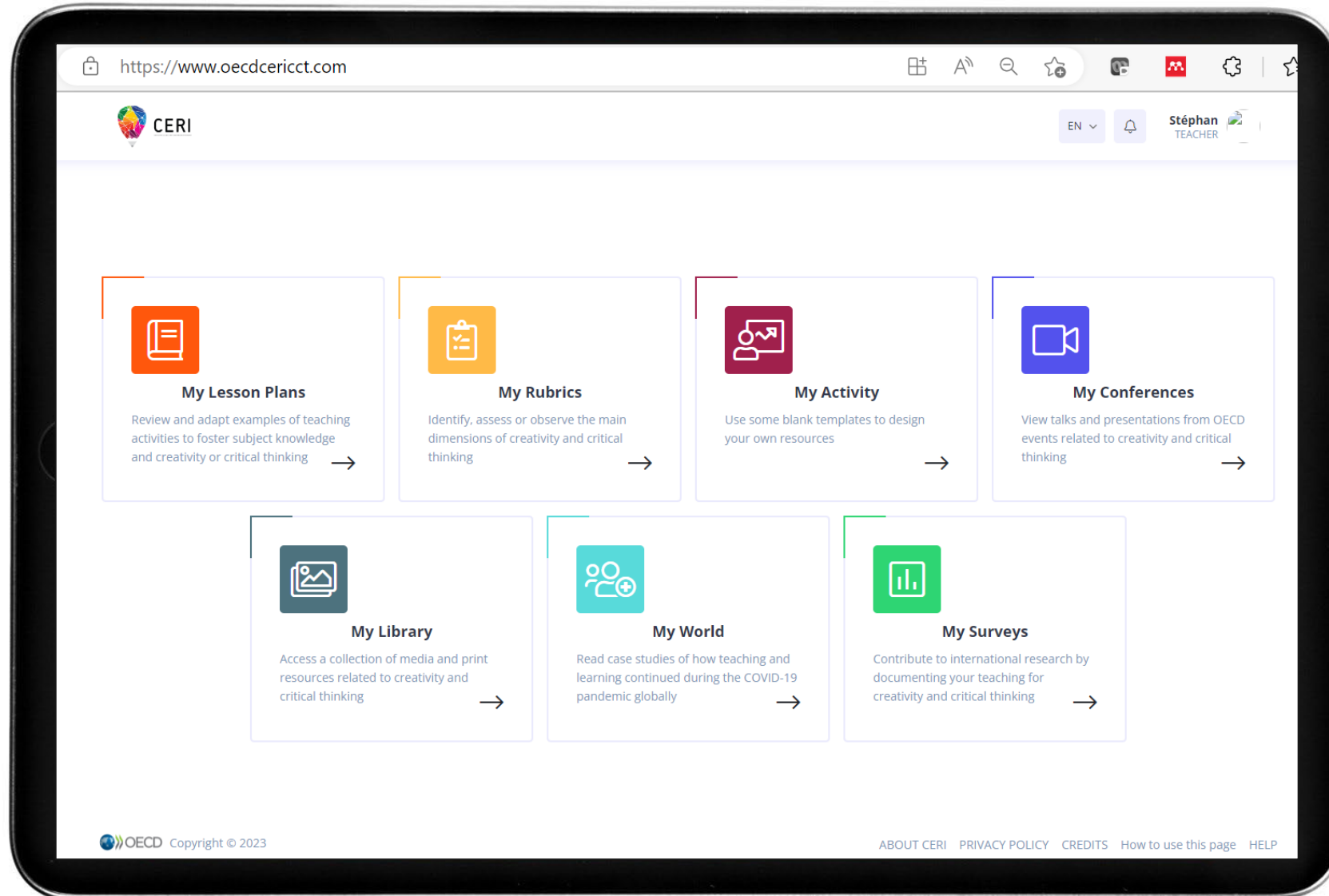
## Alignment is needed (and often missing)



- Teaching / Learning / Assessing
- Primary / Secondary / Tertiary Education
- Formative and summative assessments / Admission exams / National assessments
- Informal / Formal education



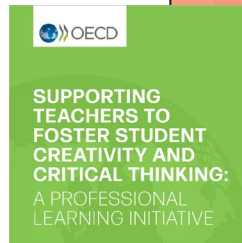
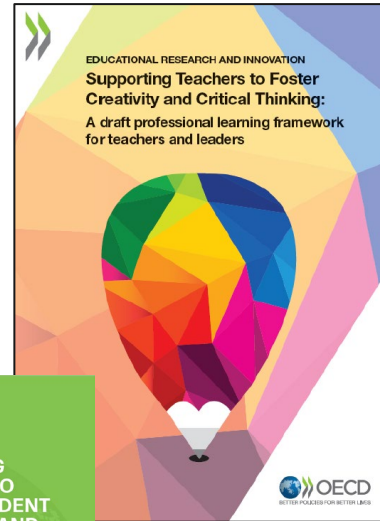
# Bank of pedagogical resources by/for teachers: [www.oecdcericct.com](https://www.oecdcericct.com)





# A professional learning programme to help (or prepare) teachers foster creativity and critical thinking

How do I make space for creativity and critical thinking?



What is creativity / critical thinking? What does it look like in my classroom?

How can I provide a flexible learning environment?

What is personal novelty?

What do creative and critical thinking have to do with my teaching?

How do I build trust for creativity and critical thinking?



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<https://oe.cd/educationceriinnovationstrategy>

