

# augMENTOR

Augmented Intelligence for Pedagogically Sustained Training and Education

Delayed, Immediate, or No AI? A Study on  
the Impact of Generative AI Timing on  
Collaborative Problem Solving



Grant agreement  
No 101061509



**Maison de l'Intelligence Artificielle (AI House) => >3000 secondary students acculturated to AI in the Nice area (France)**

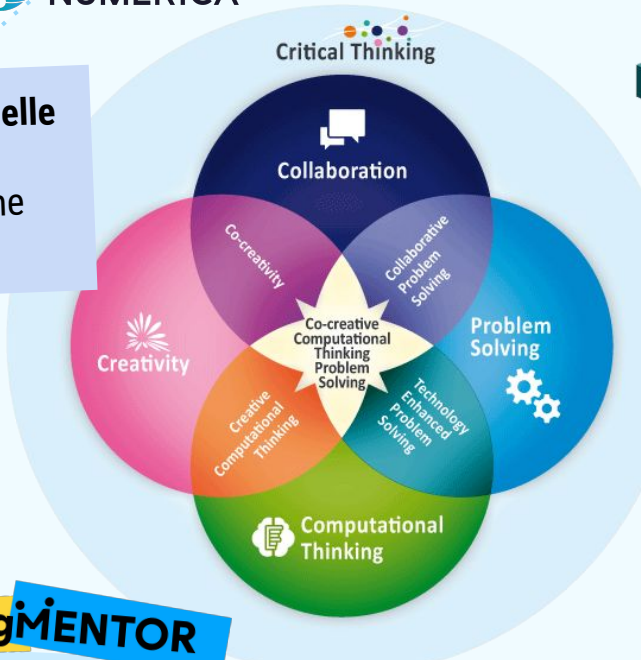
*Inria*

**The Artificial Intelligence Devoted to Education (AIDE, T. Viéville, M. Romero, F. Alexandre)** is an INRIA exploratory action aiming to advance in the study of problem solving through a combined perspective including the computational neurosciences and the learning sciences.



**ANR CREAMAKER #CREACUBE**

**The ANR CreaMaker project aims to advance in the study of individual and collective creative problem solving through educational robotics.**



**augMENTOR**

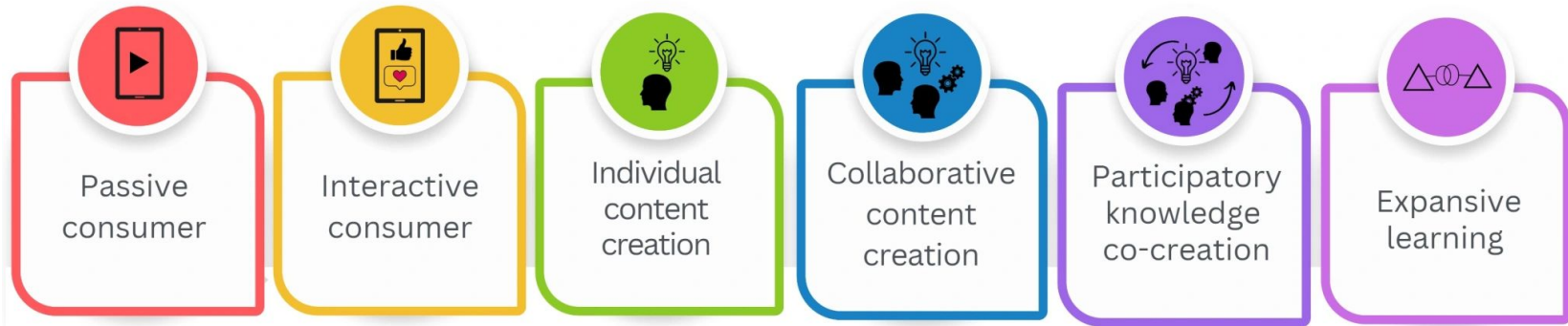
**The Horizon AugMENTOR project** adopts an augmented intelligence approach, where people and machines work together, building on their own strengths, to develop customized and collaborative learning paths.

**The GTnum #Scol\_ia** aims to advance in the study of teachers' and learners' digital competencies required in the AI era.

**GTNUM 9 #Scol\_IA**  
CRÉATIVITÉ, IA ET EDUCATION

## Six levels of **creative engagement** in Technology Enhanced Learning (TEL): the **Passive-participatory Model** (#PPai6)

- The passive-participatory model distinguishes six levels of learner creative engagement in TEL.
- **Creative engagement** is a form of engagement that is not only cognitive but also in which the learner is a creative agent, producing (or making) generative acts or artefacts.



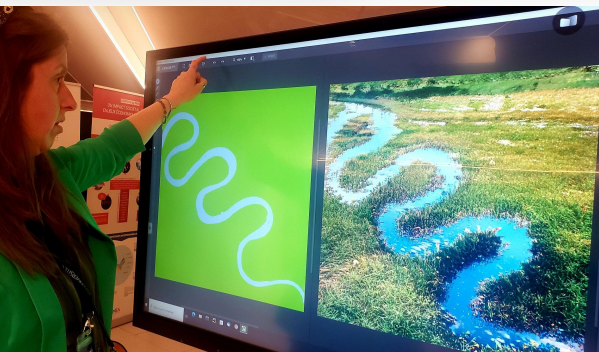
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Romero, M., Laferriere, T., & Power, T. M. (2016). [The move is on! From the passive multimedia learner to the engaged co-creator](#). *ELearn*, 2016(3).

Septiani, D.P., Kostakos, P., Romero, M. (2023). [Analysis of creative engagement in AI tools in education based on the #PPai6 framework](#). In *13th International Conference on Methodologies and Intelligent Systems for Technology Enhanced Learning*.

Expansive learning supported by AI, the sixth level of #PPai6

Preservice teachers, Inservice teachers and MSc Smart EdTech students learning design of expansive learning activities supported by AI at Terra Numerica & Maison de l'Intelligence Artificielle (MIA)



Learning activities for better understanding Artificial Intelligence activities

### Step 1. Choose a learning objective for your activity Team 2

**Choose a learning objective for your activity**

To introduce and provide basic understanding of algorithms, for ...

**Why did you choose this objective ?**

The common challenge: student face with transferring their knowledge of algorithms in everyday tasks to other context. ....

**Describe a problematic situation related to the selected objective**

While students are familiar with the use of mathematics, it can be difficult for them to see how problem solving rules can be applied to the physical world and everyday tasks. ....

**Who is the target of the learning activity?**

Young learners (primary school/elementary school) .....

### 4 Etape 2. Learning activity

**Describe the different stages of the learning activity**

<b>Preparation</b>	Introduce map symbols/vocab; angles(90°), conditions (if-then), .....
<b>Development</b>	Students use instructions to make their bicycle(character) on the map get from point a to b while anticipating the path. ....
<b>Debriefing</b>	Write the path/solution as a single line of instruction, ... students exchange paths and follow their peers instructions.

### 3 Step 3. Describe the resources

**What kind of analogical and technological technologies are required to develop your activity ?**

Grid paper (map), bicycle models (paper cutout), road-signs (paper cutout), .....

**Activity name :**

### Expansive learning supported by AI

In formative interventions supported by AI, participants' agency may expand or transform problematic situations. AI tools can be used to help identify contradictions in complex problems and help generate concepts or artifacts to regulate conflicting stimuli and foster collective agency and action. AI tools can be used to assist in the modelling of activity systems as well as in the simulation of new actions, facilitating the expansive visualization process.

Using AI to support and structure formative interventions and foster expansive learning processes e.g. suggesting relevant resources to be mobilized in problem situations, e.g using a generative model language to help verbalize and formulate disturbances and conflicting stimuli.

In this level, the participants not only generate new knowledge but they transform their practices, while conceptualizing differently and developing their agency, as a shared collaborative process between generative AI tools and human agents. AI is integrated to the creation of critical knowledge and can help to develop transformative agency.

# Study Introduction

**Rapid Integration of GenAI:** Generative AI (GenAI) tools like ChatGPT are transforming education, used for summarising, information search, and programming.

- **The Core Question:** What is the **optimal timing for GenAI use** in collaborative problem solving?
- **Study Objective:** To investigate whether immediate, delayed, or no use of AI tools mediates collaborative problem solving activity among graduate students
- **Moving Beyond "Either-Or":** Aims for a nuanced understanding of AI integration.
- **Key Finding Preview:** Delayed AI access statistically increased elaboration effort and generally fostered deeper engagement and creative outcomes

# Existing Research

- **AI in Education Context:** Previous randomized control trials (RCTs) show mixed results for AI, with some benefits but concerns regarding traditional human skills like critical thinking and creativity.
- **Leveraging Delayed Feedback Research:**
  - A body of research suggests **delayed feedback can be more effective for learning performance**, particularly for complex tasks and higher-order thinking.
  - It promotes reflection and reduces cognitive biases like the anchoring effect.
- **Hypothesis on AI Over-reliance:** Concerns that immediate AI use can lead to cognitive offloading, shortcuts, and compromised critical thinking. We hypothesize delayed access supports deeper cognitive processing

# A Controlled Study in Higher Education

- **Participants:** 36 international graduate students, randomly assigned to groups of three.
- **Task:** A 30-minute **real-world problem solving (RWPS) activity** on sustainable tourism (balancing economic development with water preservation).
- **Experimental Conditions:**
  - **Immediate AI (n=4 groups):** Continuous access to GenAI (e.g., ChatGPT, Perplexity) throughout the task.
  - **Delayed AI (n=4 groups):** 15 minutes of unaided collaboration, followed by continuous GenAI access. This period allowed for independent ideation.
  - **No AI (n=5 groups):** No access to GenAI at any point.
- **Outcome Evaluation:** Two independent researchers assessed solutions.
  - **Six Criteria: Elaboration effort** and five transversal competencies (the 4Cs + Problem Solving)

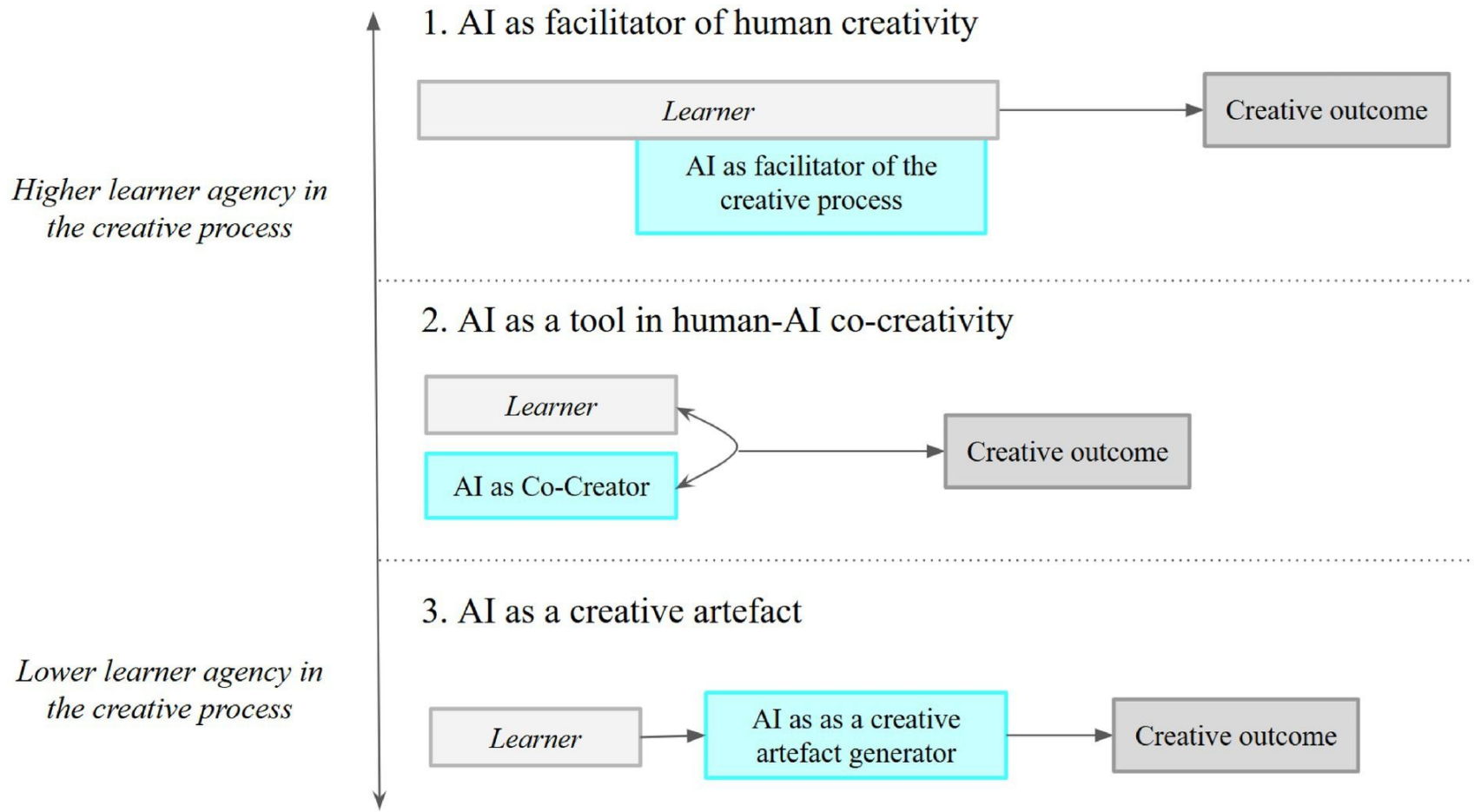
	<i>immediate AI</i> (n=4)	<i>delayed AI</i> (n=4)	<i>no AI</i> (n=5)
Elaboration	M=1.00, SD=0.00	M=2.13, SD=0.85	M=0.90, SD=0.63
Collaboration	M=0.25, SD=0.50	M=1.00, SD=0.82	M=0.60, SD=0.89
Communication	M=0.25, SD=0.50	M=1.00, SD=0.82	M=0.40, SD=0.55
Creativity	M=1.00, SD=0.82	M=1.75, SD=0.50	M=0.70, SD=0.84
Critical Thinking	M=0.50, SD=0.58	M=1.00, SD=0.82	M=0.80, SD=0.84
Problem Solving	M=1.25, SD=0.50	M=1.25, SD=0.87	M=0.60, SD=0.89

# Impact of AI Timing on Outcomes

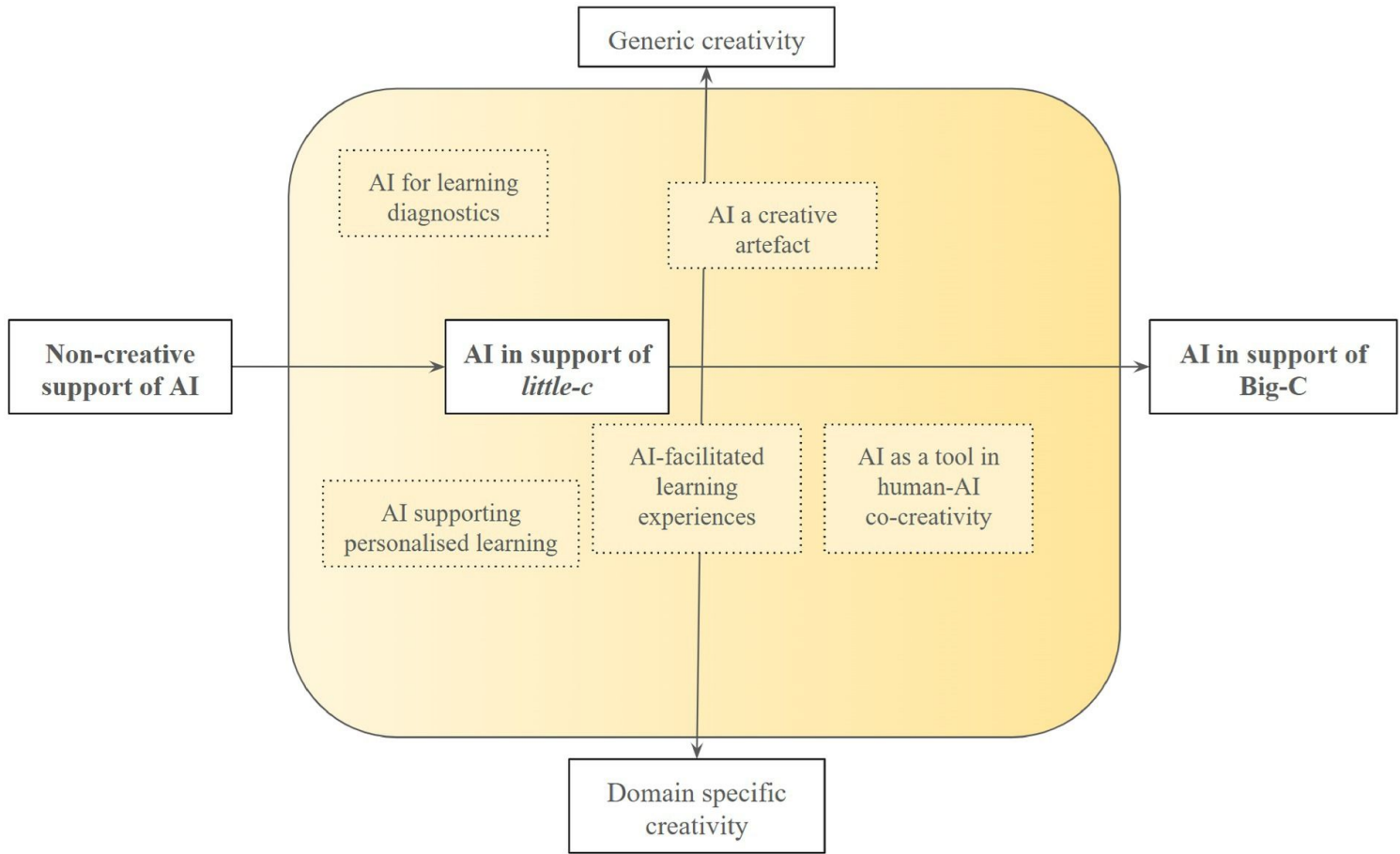
- **Overall Trends:** The **delayed AI group generally reported the highest average scores** across most competencies, particularly in elaboration and creativity.
- **Statistically Significant Result:**
  - **Elaboration Effort:** A **statistically significant difference was observed, favoring the delayed AI groups** ( $M=2.13$ ,  $SD=0.85$ ) over the no AI groups ( $M=0.90$ ,  $SD=0.63$ ,  $p=0.034$ ).
  - No significant differences were found for other competencies.
- **Qualitative Insights - Immediate AI:**
  - Produced **grammatically correct but homogenised outcomes**, often directly copy-pasted from AI.
  - **Rarely showed evidence of critiquing AI-generated responses**, treating AI output as final.
  - Indicated a potential homogenising effect.
- **Qualitative Insights - Delayed AI:**
  - Demonstrated a **more thoughtful and elaborate problem-solving approach**.
  - Used initial ideas as a foundation before leveraging AI for refinement or expansion.
  - AI functioned as a **collaborative partner**, leading to more original and less homogenised outcomes.
- **Qualitative Insights - No AI:**
  - Presented **mixed results:** one group was highly creative, while others showed very low elaboration and minimal solutions, indicating disengagement.
  - The absence of AI did not guarantee higher engagement or creativity.

# Balancing Efficiency with Depth

- **Delayed AI as a Balanced Approach:** This condition emerged as **most effective**, fostering deeper engagement, elaboration, and creativity by allowing initial unaided collaboration. AI acts as a scaffolding tool for refinement and expansion.
- **Immediate AI Risks:** Leads to **polished but homogenised solutions and potential cognitive offloading**. This preempts critical thinking and leads to over-reliance.
- **The "No AI" Challenge:** Simply removing AI doesn't guarantee effort or creativity; **some groups disengaged** and produced minimal work. Intentional task design and scaffolding are crucial regardless of AI presence.
- **Trade-offs:** Our results highlight a **trade-off between efficiency (immediate AI) and creative depth (delayed AI)**.



Typology of AI's role in the creative process (Romero, 2025).



Typology of AI's role in the creative process.

<https://www.frontiersin.org/journals/education/articles/10.3389/feduc.2025.1602151/full>

# Policy & Pedagogical Implications

- **Intentional Scaffolding:** Educators should design curricula that **intentionally scaffold phases of AI use**, rather than offering unrestricted access.
- **Teach AI Critiquing Strategies:** Explicitly teach students to **critique and iterate on AI responses** to prevent cognitive offloading.
- **Avoid Simplistic Assumptions:** Removing AI does not automatically foster authentic or creative work

# Conclusions & Future Directions

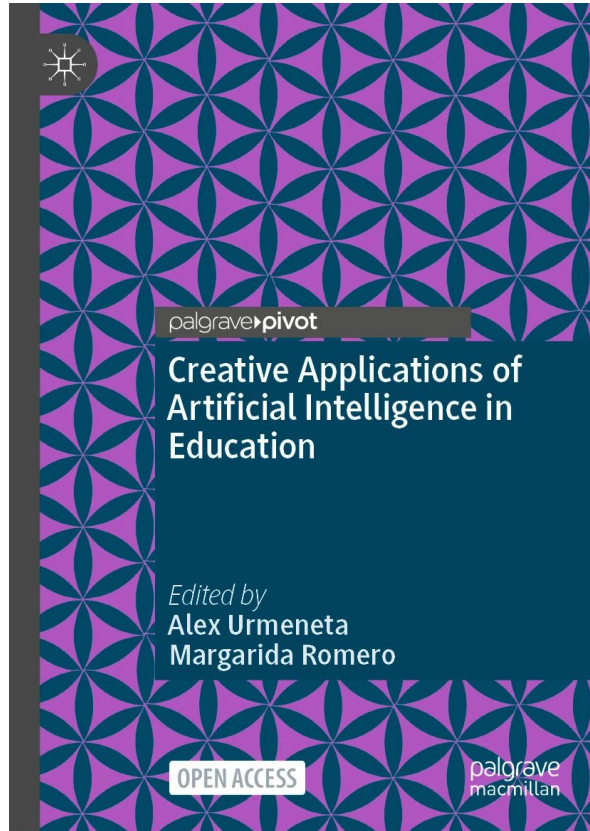
- **Key Takeaway:** The **timing of GenAI integration profoundly influences collaborative problem-solving outcomes** and transversal competencies. **Delayed access emerged as the most beneficial approach.**
- **Future Research:**
  - Investigate optimal timing across diverse learning contexts (e.g., essay writing, project-based learning) and subject areas.
- **Final thought:** How can we best leverage AI as a **partner, not a replacement**, for human cognitive effort?

Open access book

## “Creative application of artificial intelligence to education”

> 114 k readings

<https://link.springer.com/book/10.1007/978-3-031-55272-4>



Creative  
Uses of AI in  
Education

Part 1. Creative  
Uses of AIED

**Chapter 1.** Creative Application of Artificial Intelligence in Education

**Chapter 2.** Preserving Teacher and Student Agency: Insights from a Literature Review

**Chapter 3.** Learning Artificial Intelligence Through Open Educational Resources

**Chapter 4.** Digital Acculturation in the Era of Artificial Intelligence

**Chapter 5.** Citizenship, Censorship, and Democracy in the Age of Artificial Intelligence

**Chapter 6.** International Initiatives and Regional Ecosystems for Supporting Artificial Intelligence Acculturation

**Chapter 7.** Informal Education Practices for Human-AI Creative Pedagogy for Accessibility and Inclusivity

**Chapter 8.** Students' Perspective on the Use of Artificial Intelligence in Education

**Chapter 9.** Affordances for AI-Enhanced Digital Game-Based Learning

**Chapter 10.** Generative Artificial Intelligence in Higher Education

**Chapter 11.** Artificial Intelligence in Professional and Vocational Training

**Chapter 12.** Manifesto in Defence of Human-Centered Education in the Age of Artificial Intelligence

Part 2. AI in K-12  
Education

Part 3. AI in  
Higher Education