

# Beyond Tools: Transitioning and Repairing Epistemic Infrastructure in Education

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# About Bodong

## Interests

- Knowledge Building
- Learning analytics
- Digital transformation



## Penn Wonder Lab

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Sorry I know nothing about  
**Computational Thinking...**

# At the **Center for Learning Computational Thinking**

At CLCT, we define CT as the cognitive processes involved in developing IT artifacts and programs to live in the world today.

We understand this in a broad sense, so that critical reflection on the design and use of IT artifacts is an integral part of their development. ...

In its broadest sense, we view CT as **a problem-solving process aimed at finding creative solutions to the significant societal problems facing the world today**.

# Consider CT broadly

1. **Computational Thinking** (Wing, 2006)
2. **Computational Participation** (Kafai & Burke, 2014)
3. **Computational Empowerment** (Dindler et al., 2020)

Contemporary views on CT ... should focus on articulating how humans can design for, partake in, and critically appraise human–machine collaborations (Nina Bonderup Dohn, 2024, p. 850).

# Knowledge Building

A theory and pedagogy, developed by **Marlene Scardamalia** and **Carl Bereiter**, that treats the production of knowledge as the central focus of education.

It represents a fundamental shift from traditional approaches to learning:



- Students: consumers → **active creators**
- Knowledge: **objects** to be improved
- Learning: advancing knowledge in a **community**

# Unpack Knowledge Building

## 1. **Knowledge transformation by experts** (Bereiter & Scardamalia, 1987)

- Knowledge telling → knowledge transformation

## 2. **Knowledge-building communities** (Scardamalia & Bereiter, 1994)

- Collective responsibility for knowledge advancement

## 3. **Epistemic agency, knowledge for public good**

- Students taking high-level responsibility
- Critical awareness of knowledge creation processes
- Knowledge work contributing to public knowledge

# Parallels between CT and KB

Parallel Aspect	Computational Thinking	Knowledge Building
Individual to Collective	Individual programming skills → computational participation	Individual knowledge work → collective knowledge advancement

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Technical to Social	Coding skills → social and cultural dimensions	Individual knowledge → community knowledge

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Technical to Social	Coding skills → social and cultural dimensions	Individual knowledge → community knowledge
Human Agency	Emphasizes computational agency	Emphasizes epistemic agency

Both KB and CT care about enhancing  
**human epistemic agency**<sup>1</sup>  
in the world

1. Every time we act in an effort to attain our epistemic goals, we express our epistemic agency (Ahlstrom, 2010).

A large, detailed statue of an African elephant stands in the middle of a modern office. The office has white walls, a large window on the left, and various office furniture like desks, chairs, and bookshelves. The elephant is positioned as if it's walking through the office, with its trunk down and its large ears visible. The lighting is bright, creating a stark contrast between the dark statue and the light-colored office interior.

However,  
**human epistemic agency**  
is challenged by generative AI

# Develop a lesson plan aligned with curriculum

Khanmigo for teachers



# Generate instructional materials

The image shows a smartphone screen with a TikTok video player. At the top, there's a white bar with a magnifying glass icon and the word "Fit". Below it, a white box contains the text "Emoji Reaction Student Activity by Ditch that Textbook!". The main video frame has a yellow header with the words "Emoji reaction". The video content itself is a text-based slide with the following text:  
**Instructions:** Read the text then respond social media! To express your reaction to t your feelings into the circle. Next, use the t highlights your reaction. Finally, type your t comment box provided.  
The American Revolution, a War for Independence, was history. It was a war fought b American colonies and Great colonies gaining independenc States of America. The war be Battles of Lexington and Concord with the signing of the Treaty o



# Students chatting with AI characters



SDU • 6/16/2025

# "Instant feedback" on student thinking

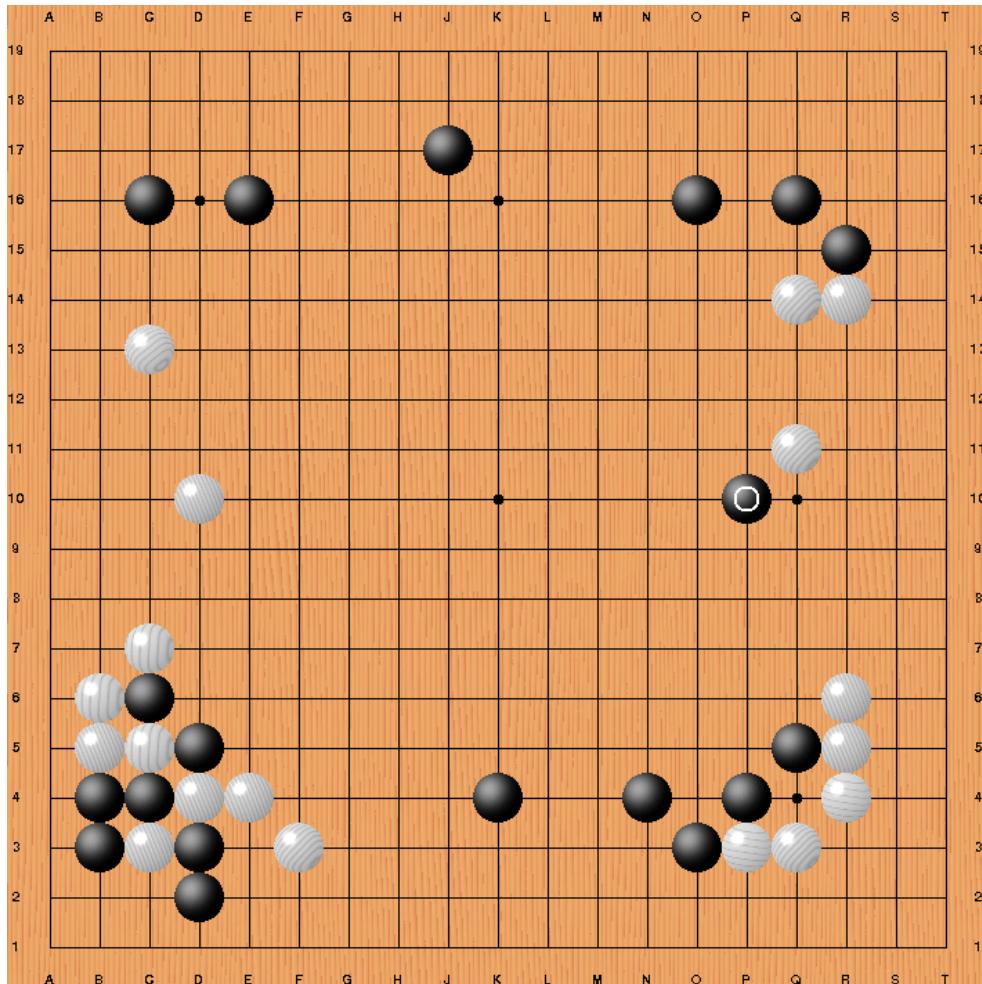
Snorkl Demo | Instant Fee...





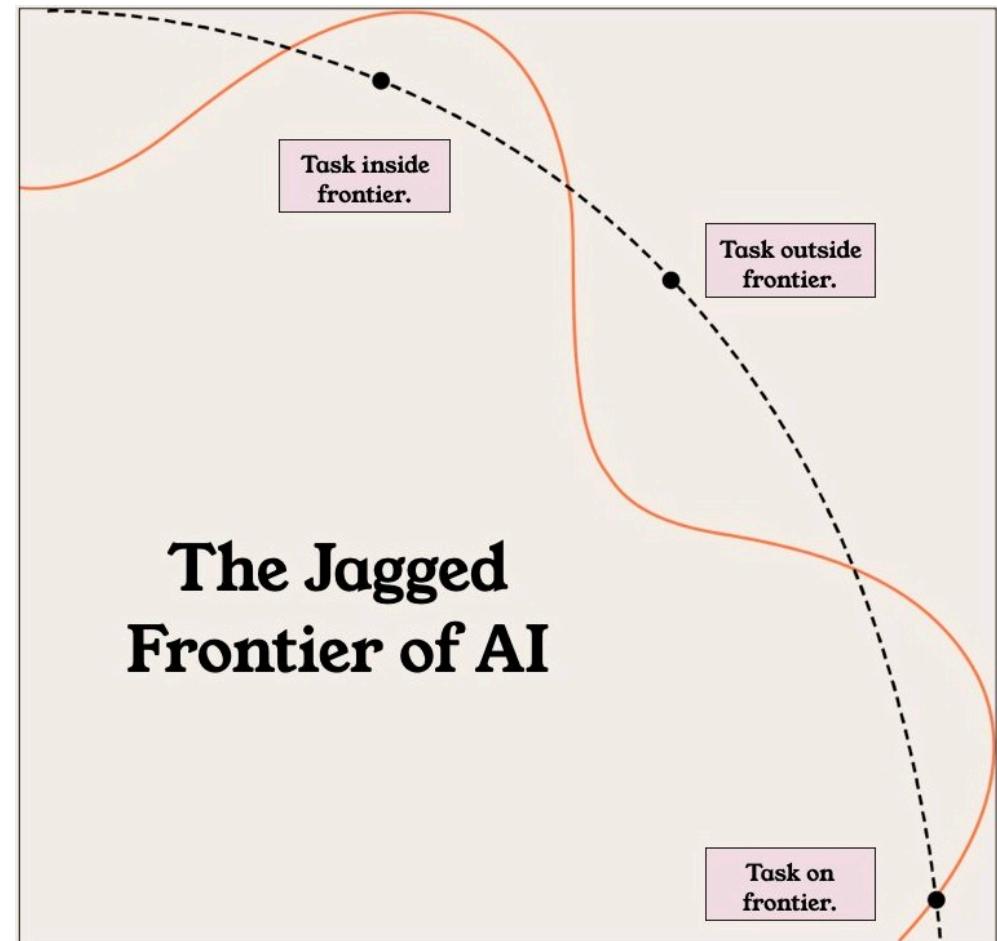
An ongoing **societal transformation**  
involving the **redistribution** of  
**labor, agency, and creativity**  
between **human** and **non-human** entities

“Superhuman performance”



(Move 37)

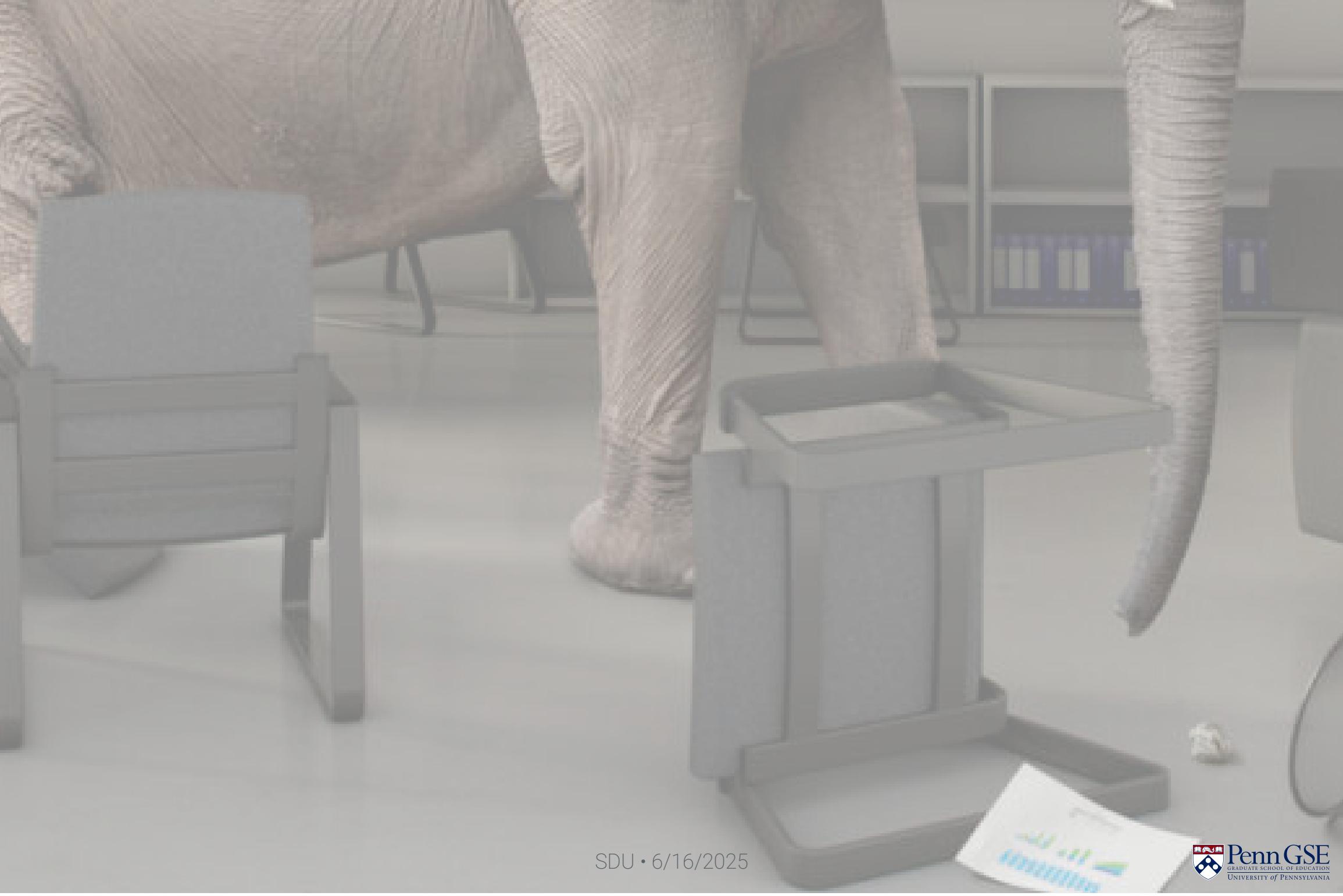
“Jagged frontier”



(Dell'Acqua et al., 2023)

A close-up photograph of an elephant's head and trunk, looking slightly to the right. The elephant has wrinkled, grey skin. The background is a soft, out-of-focus grey.

How to navigate the  
transformation  
with care?



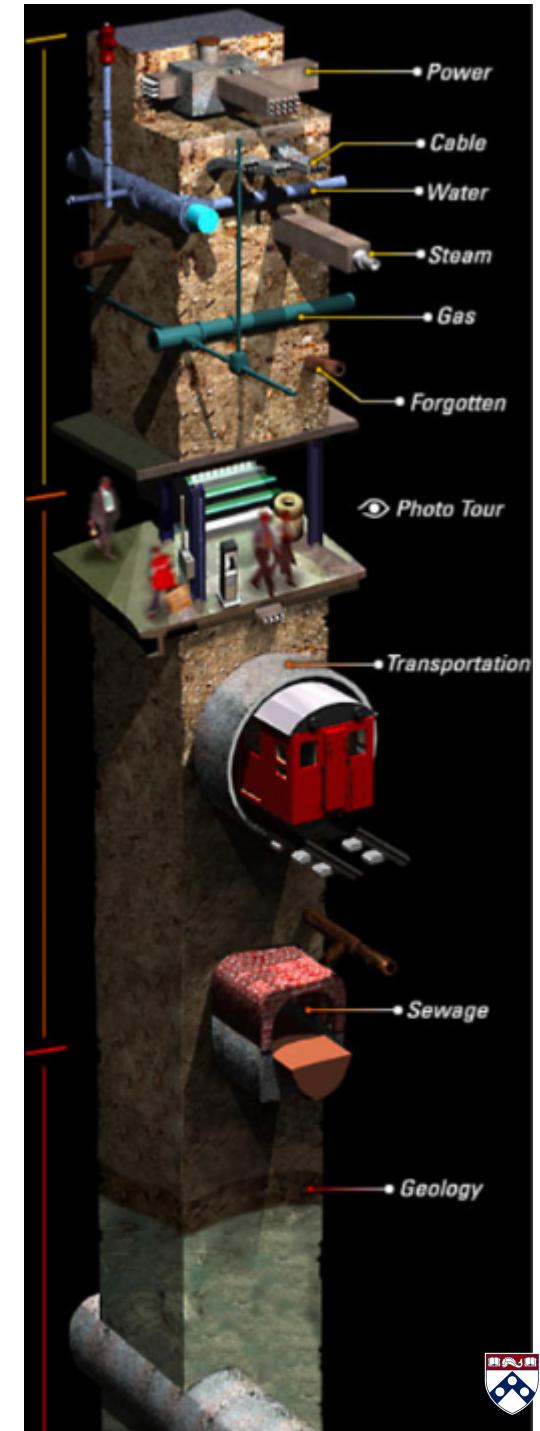
SDU • 6/16/2025

# Two Perspectives

# 1. Infrastructure

"the basic physical and organizational structures and facilities (e.g. buildings, roads, power supplies) needed for the operation of a society or enterprise."

- Embedded, hidden
  - Relational, socio-political
- (Bowker, 1994; Star, 1999; Read, 2019)



# Infrastructure – as verb

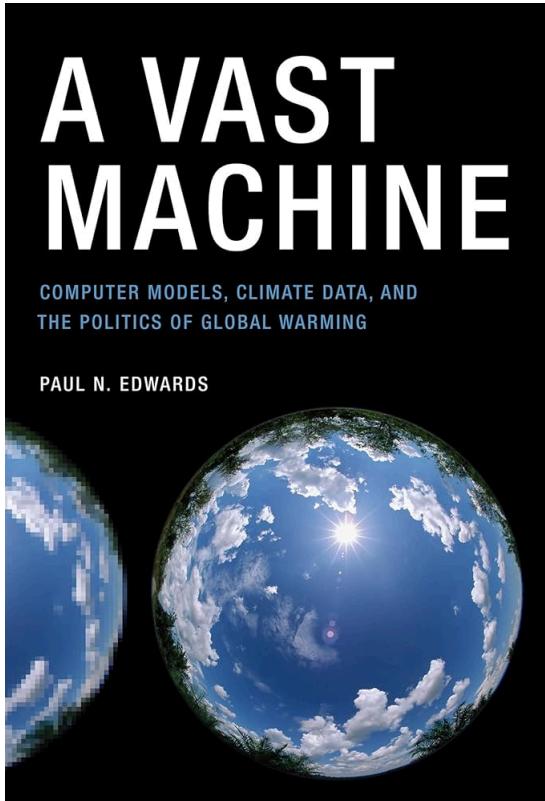
the ongoing process of design and redesign when an infrastructure is created in a setting (Karasti & Syrjänen, 2004)

- Blurs the boundary between users and designers
- Recognizes ongoing design work
- Constant “repair” (Mikalsen et al., 2018)

# Epistemic Infrastructure

- Structures and systems that “enable individuals and societies to know what they know and to do what they do” (Hedstrom & King, 2006)
- Related terms: knowledge infrastructures (Edwards, 2010); thinking infrastructures (Kornberger et al. 2019)

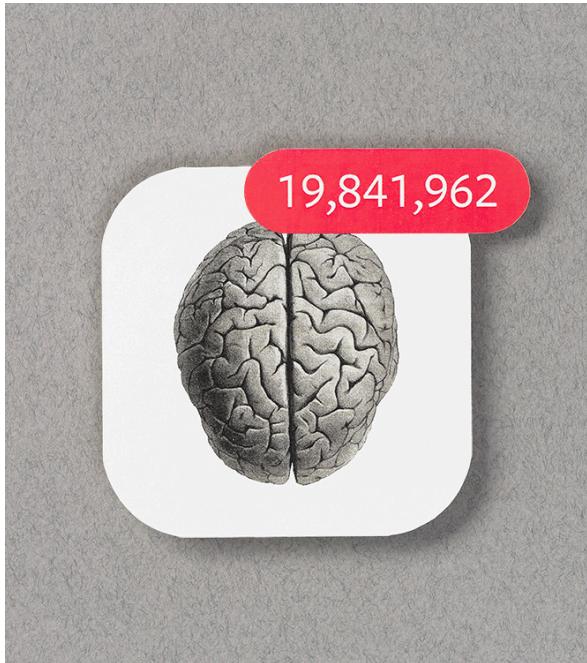
# Epistemic Infrastructure



For climate science: "Robust networks of people, artifacts, and institutions that generate, share, and maintain specific knowledge about the human and natural worlds" (Edwards, 2010)

- Climate scientists, the public, etc.
- Satellites, sensors, computer models, etc.
- Truthfulness, evidence, consistency
- Emergency responses, policies, personal actions

# Epistemic Infrastructure

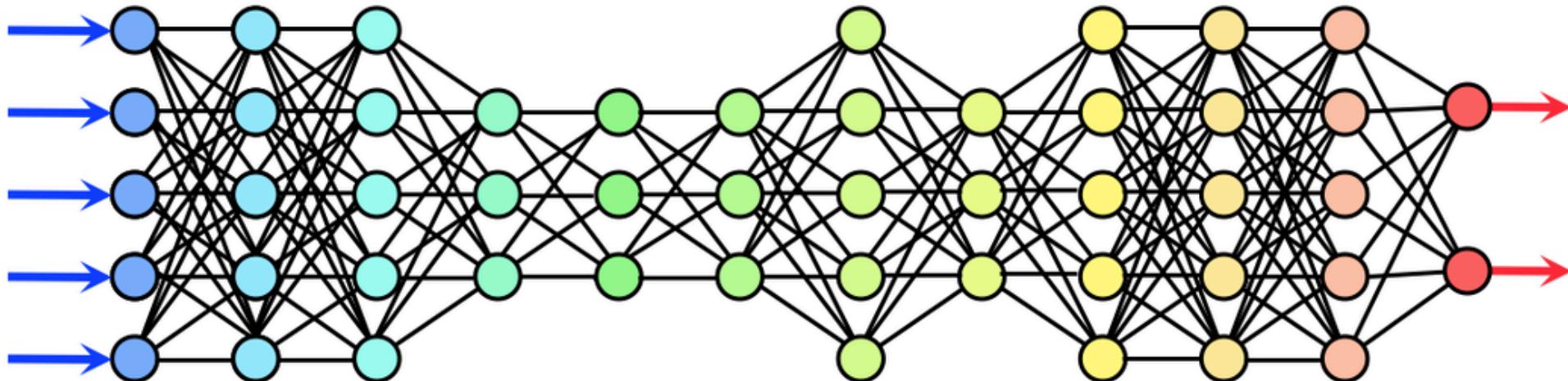


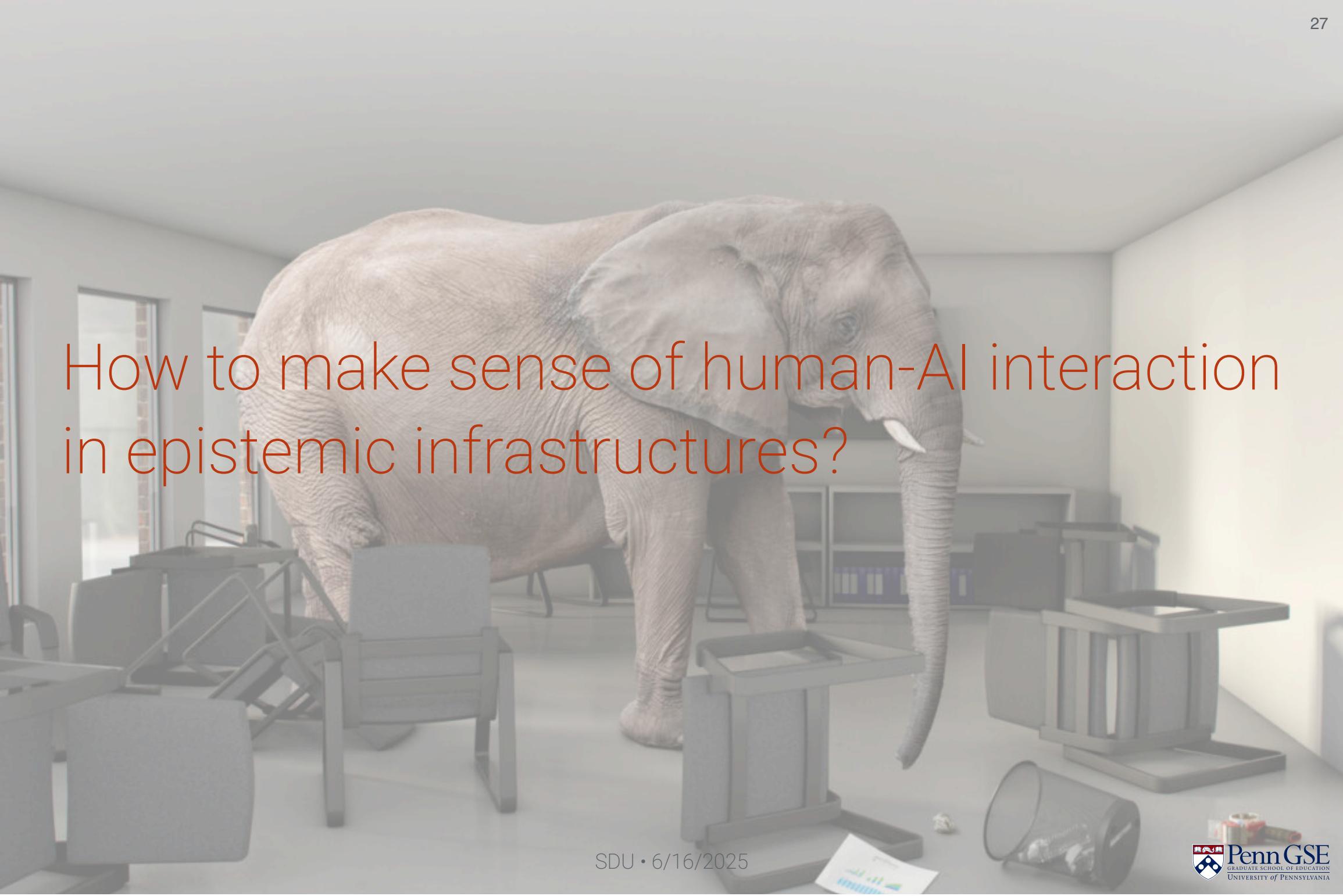
Social media for climate discussions: Bad faith communication fueled by political polarization and attention economy

- Users who consume and react to content
- Personalization, sorting algorithms, notifications
- Contested epistemic norms
- Little consequence

# Hampers Epistemic Agency

- If supporting apt epistemic performance is not the goal
- If one dominant way of knowing edges out other ways of knowing, e.g., “fast knowledge” pushes out “slow knowledge” (Orr, 1996)
- In the AI case, if “parametric knowledge” of AI models pushes out humane ways of knowing



A large, light-colored elephant stands in the middle of a modern office. The office has white walls, a high ceiling, and large windows on the left. In the background, there are bookshelves filled with books and some office equipment. In the foreground, there are several office chairs, a desk, and a trash can. The elephant is positioned in the center, partially obscuring the office furniture.

# How to make sense of human-AI interaction in epistemic infrastructures?

# 2. Situated Cognition

Cognitive processes extend beyond the brain to include the body and environment

- views the brain, body, and surrounding environment as an integrated cognitive system in continuous interaction (Carney, 2020)
- the mind as a “dynamic coupling” of brain–body–world (Newen et al., 2018; Robbins & Aydede, 2008).

# A Situated Approach to Analyzing Epistemic Agency and Infrastructure

Consider the agent–infrastructure interaction

Dimensions	Description
Skilled actions	A range of actions users can carry on
Epistemic sensitivity	Conditions for activating these skilled actions to meet epistemic goals
Habit building	Repeated actions and interactions that build epistemic habits



AI—when carelessly deployed—threatens:

1. Epistemic infrastructure in education
2. Situated cognition and action by humans

# Case 1: Generate lesson plans

Magic School AI

5E Model Lesson Plan

Generate a 5E model lesson plan for your science class. Engage, Explore, Explain, Elaborate, Evaluate.

Grade level:

8th grade

Topic, Standard, or Objective:

What role do muscles, tendons, ligaments and bones play in allowing a human to walk?

Additional Customization (Optional):

We are exploring the musculoskeletal system and its functions. The guiding question for our lesson is how do bones, muscles, tendons and ligaments work together to allow humans to walk around their environment?

Standards Set to Align to (Optional):

NGSS

Generate

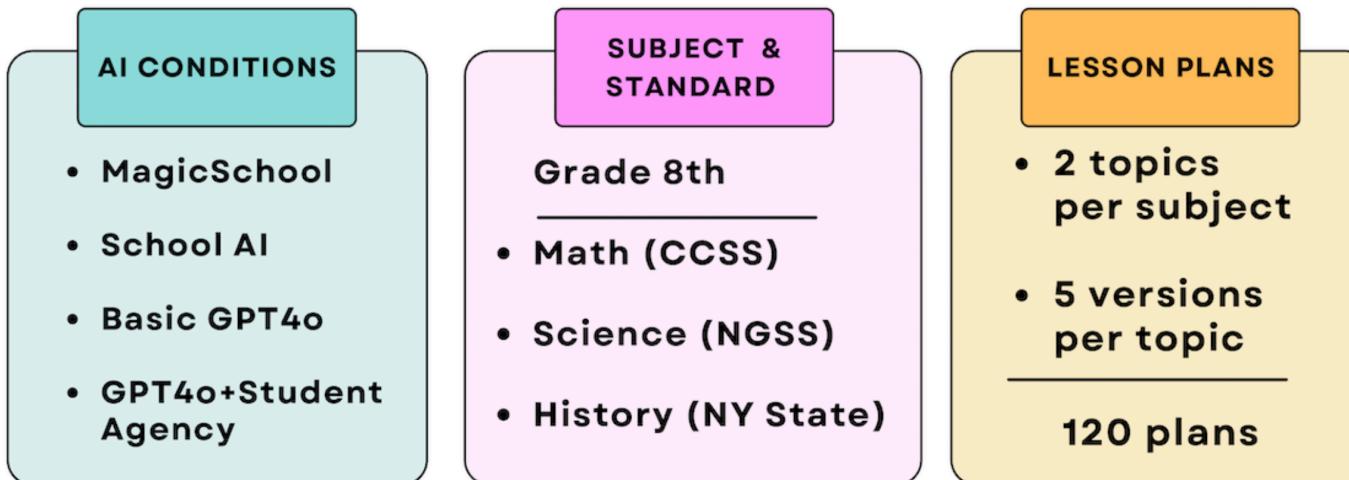
**Skilled actions:** Teachers design lessons based on pedagogical principles and student backgrounds

**Epistemic sensitivity:** Steering prompts, but AI generation remains opaque

**Habit building:** Speed, reliance, and no native support for iteration

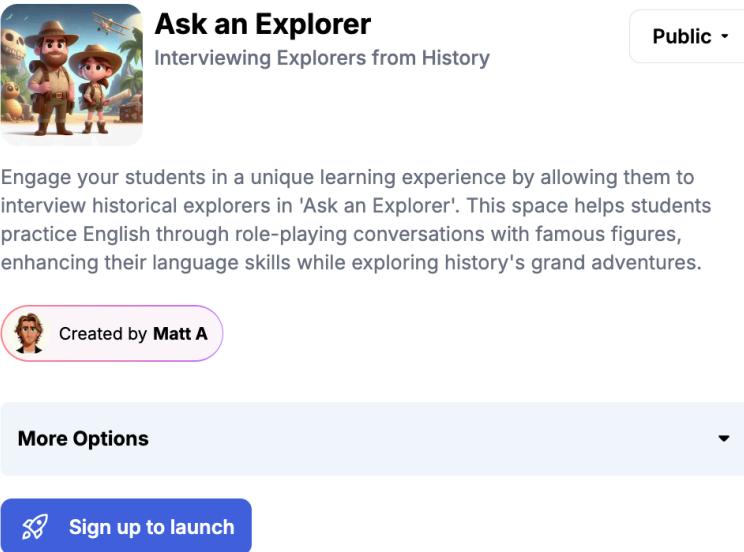
# Problem with current lesson plan generators

- Position teachers as *end-users* rather than *designers*
- Pedagogical biases (Cheng et al., 2025)
  - Limited student agency (teacher centered)
  - Uninspiring classroom dialogue (rote, teacher-class)



# Case 2: Build AI characters for students

## School AI



**Ask an Explorer**  
Interviewing Explorers from History

Public

Engage your students in a unique learning experience by allowing them to interview historical explorers in 'Ask an Explorer'. This space helps students practice English through role-playing conversations with famous figures, enhancing their language skills while exploring history's grand adventures.

Created by **Matt A**

More Options

Sign up to launch

**Skilled actions:** Teachers nurture diverse perspectives and facilitate dialogues. Students consider multiple perspectives.

**Epistemic sensitivity:** Teachers can design interesting chat experiences. Students converse with artificial figures, but may not have time to fact check.

**Habit building:** Isolated dialogues with chatbots, lack of communal discourse and epistemic responsibility

# Case 3: Provide feedback on essays

Diffit

The screenshot shows a Microsoft Word document with several paragraphs of text about Mesopotamian civilization. Two AI-generated feedback pop-ups are overlaid on the text:

- Accuracy of Historical Information:** A comment from Suvi Gluskin points out that while it's true the Sumerians developed cuneiform, they were not necessarily the earliest inhabitants of Mesopotamia. It suggests considering the statement accurate to reflect the historical timeline.
- Evidence and Source Credibility:** Another comment from Suvi Gluskin discusses the debate over the existence of the Hanging Gardens of Babylon, noting there is no concrete archaeological evidence to support it. It asks if a credible source supports the claim.

**Skilled actions:** Teachers provide personal feedback to students

**Epistemic sensitivity:** Teachers can review before submitting each comment, but AI decides where to provide feedback

**Habit building:** Speed, reliance, and over time less knowledge about students

# Agent–Infrastructure Interactions

- Skilled epistemic actions of teachers and students are not sufficiently considered and are in tension with speed and efficiency
- While some AI tools leave space for humans to exercise their skilled actions, they are in general designed or advertised in ways that reduce epistemic sensitivity
- AI tools provide opportunity for quality checks. But interactions typically favor instantaneous generation over iteration. Reduced epistemic operations by humans create habits that would lead to reduced human knowledge of practice, and of other humans.

# Potential Responses?

# Proj 1: CraftPad: Teachers as Designers

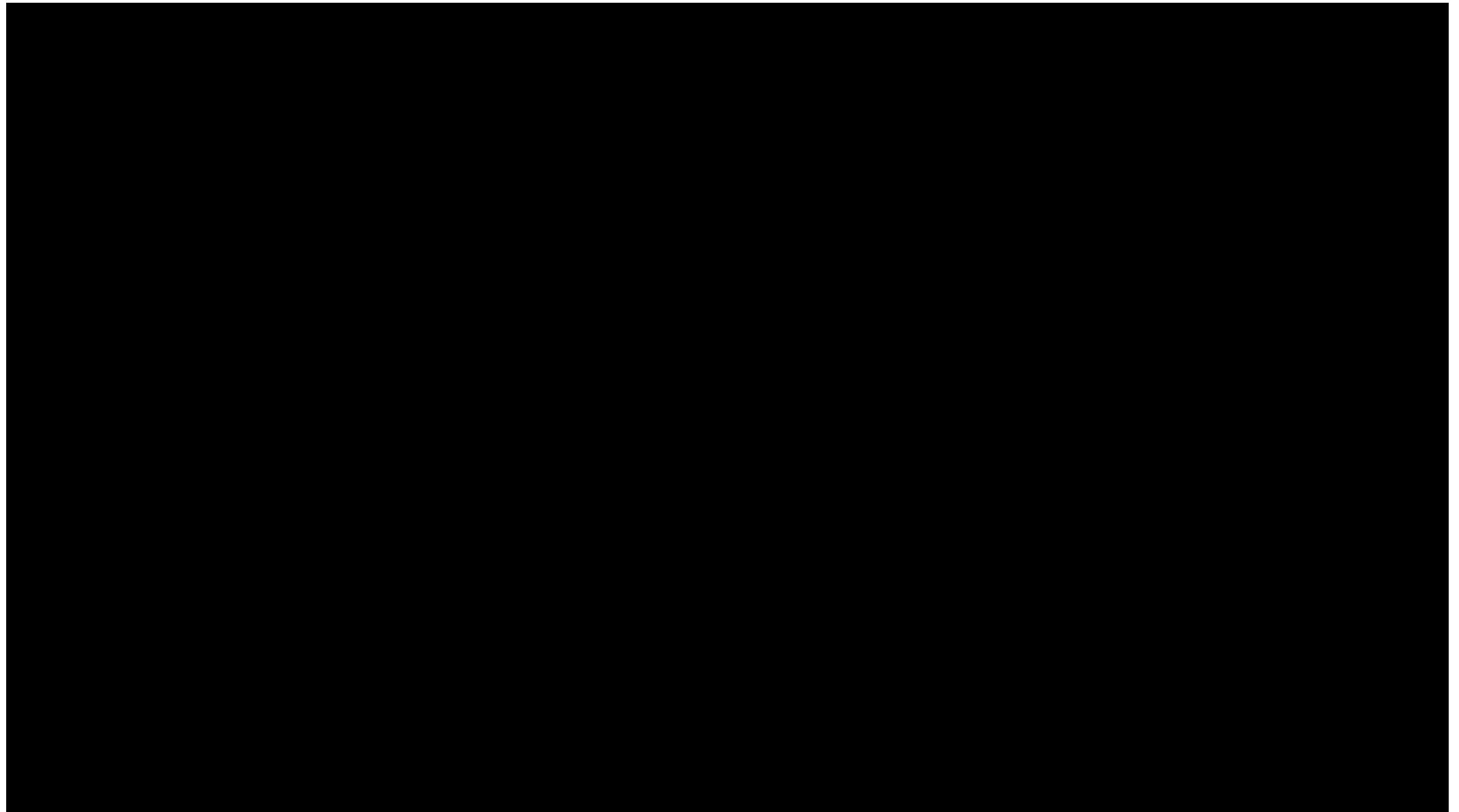
## *Design Goals*

- Support teachers to iteratively design KB lessons

## *Approach: Meta-Design*

- Position teachers as designers, not merely users
- Center teacher expertise and epistemic agency
- Support complex, nuanced work of knowledge building design

# CraftPad: Demo



# Proj 2: Mixed-initiative design patterns

## *Design Goals*

1. Augment students' creative work
2. Promote students' AI competency

## *Approach:*

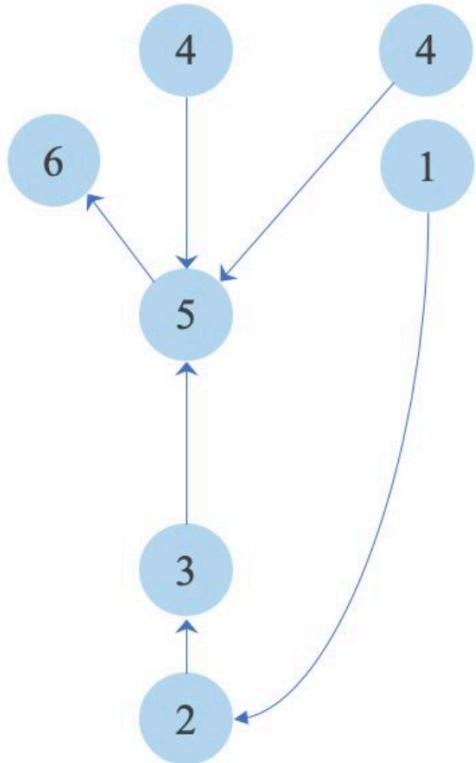
- Mixed-Initiative Creative Interfaces

Chen, B., Zhu, X., & Díaz del Castillo H., F. (2023). Integrating generative AI in knowledge building. *Computers and Education: Artificial Intelligence*, 5, 100184.  
<https://doi.org/10.1016/j.caeari.2023.100184>

# Design Patterns

## Design Pattern 1

## Student ChatGPT



# **Knowledge-Creating Dialogue Moves**

## Problem definition

New ideas

## Promisingness evaluation

## Meta-dialogue

## Comparison

Critical discourse

## Higher-level ideas

## Design Pattern 2

## Student ChatGPT

# Key Insights

- The use of AI made learning harder—rather than easier—when mindful engagement is needed
- Students took high-level agency in the process
- Cope with ‘Stochastic parrot’  and ‘Concentrated owl’ 
- We need more design patterns to purposefully integrate AI in collaborative learning

# Departing Thoughts

## 1. Beyond tools

AI systems in education are **more than tools**. They are often epistemic infrastructures that shape our actions, habits, relations for years or decades to come.

## 2. Infrastructures need repair

Due to mis-alignment with societal values,  
but also pedagogical values.

Therefore, they are **broken by default**  
and need constant care and repair.

### 3. A vast design space

is presented in front of us if we adopt a situated perspective. We need more designs that center relationship and human experience. We need more diverse voices to explore the space.

# What roles should CT play?

I look forward to learning from you all!

# Thank You!

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