Panel Discussion

AI in Education: Advancing Theory, Responsible Use, and Funding Priorities

Regency B
Tuesday, 1:30 – 2:45 pm

Presenters

Panelists

- N. Sanjay Rebello, Purdue University
- Victor Lee, Stanford University
- Zhen Bai, University of Rochester

Moderator

- Kevin Clark, National Science Foundation

Investing in Americans:

Artificial Intelligence (AI) Education and Workforce at the U.S. National Science Foundation (NSF)

Kevin Clark, PhD
Program Director
kevclark@nsf.gov

June 2026

Four Pillars of AI at NSF

- AI for Science
- Future of Intelligence
- AI Infrastructure
- AI Education & Workforce

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Cross-cutting Themes of AI at NSF

Empowering AI innovation

- Supporting fundamental research to develop new AI methods and technologies
- Building pathways to transition AI innovations into practice

Fostering the next generation of breakthroughs through AI

- AI-powered discovery across all fields of science and engineering
- AI is used for research and discovery in nearly every program at NSF

Forging partnerships and supporting workforce development

- Investing in educational programs and tools to build a world-class AI-ready workforce
- Powering regional innovation and economic development

NSF AI Workforce and Education Programs

NSF National AI Research Resource
(NAIRR Classroom for educators)
> 60 awards and > $46M worth of in-kind compute/cloud resources made available from AWS, Google Cloud, Microsoft, NVIDIA and Vocareum

NSF National AI Research Institutes - Educational Outreach

- 13+ NSF AI Institutes have AI educational outreach programs

National AI Institute for Exceptional Education partnering with $400M Empire AI consortium on AI Computing Center

NSF Expanding AI Career & Skilled Workforce Opportunities for High School Students
(NSF ExLENT & NSF ATE)

Additional $15.6M to fully support 65 awards
Partnership with Micron (ExLENT)

NSF AI Workforce and Education Programs (Cont.)

NSF CyberCorps® Scholarship-for-Service (SFS): Artificial Intelligence & Cybersecurity

- **Up to 25 awards, maximum award amounts $500K for Innovation Track and $2.5M for Scholarship Track**

NSF Improving Undergraduate STEM Education (IUSE)

- Innovation in Two-Year College STEM Education (ITYC)
- **$61M per year**

NSF Innovative Technology Experience for Students & Teachers (NSF ITEST)

- **$25M - $30M per year**

NSF Future CoRe: Computing Education Research

- **Up to 25 awards, $15M**

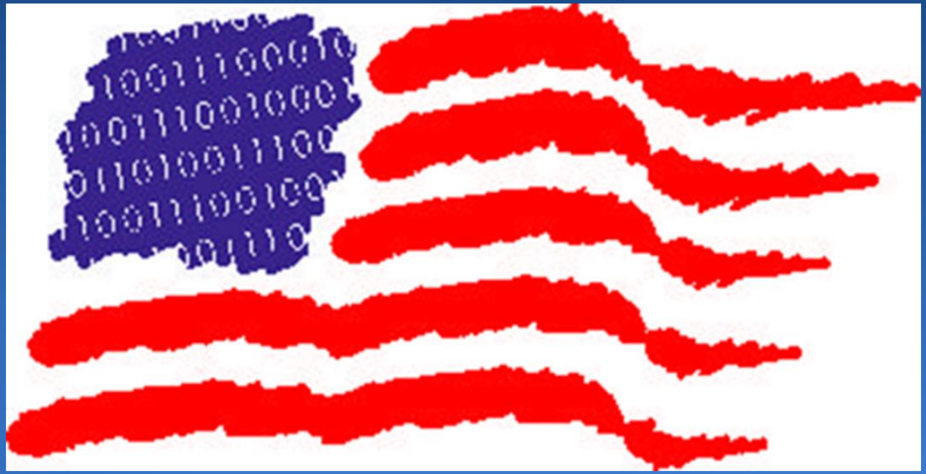

Image Credit: Cybercorps®

NSF AI Workforce and Education Programs (Cont.)

NSF Collaboratory to Advance Mathematics Education & Learning for K-12
(NSF CAMEL)

$9M from NSF, Walton Family Foundation, and other philanthropic partners

NSF Tech Access: AI-Ready America
Partnerships with USDA, Department of Labor, and Small Business Administration

Anticipated funding amount totals of $168M - $225M for ~56 Coordination Hubs

NSF Fostering Interdisciplinary Networks to Develop Emergent and Responsive Solutions Foundry
(NSF FINDERS FOUNDRY)

~50 planning awards of $50K each, and ~20 development awards of $300K each

Image Credit: NSF

Email: kevclark@nsf.gov

Visit: https://www.nsf.gov/focus-areas/ai

AUTOMATED FORMATIVE FEEDBACK OF PROBLEM-SOLVING STRATEGY WRITING IN INTRODUCTORY PHYSICS USING NLP

N. Sanjay Rebello, PI & **Amir Bralin**, Graduate Assistant
Department of Physics & Astronomy

Dan Goldwasser, Co-PI & **Younghun Lee**, Graduate Assistant
Department of Computer Science

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THE PROBLEM

HOW DO WE ASSESS STUDENTS' WRITTEN STRATEGIES FOR SOLVING PHYSICS PROBLEMS & PROVIDE FEEDBACK?

- Strategy writing can improve students' problem solving.
- No feedback can be provided without assessment.
- But assessing students' written strategies can be prohibitive.

GOALS

1. To determine the accuracy with which we can we classify as correct or incorrect, students' essays describing their strategies for solving a problem.
2. To determine the extent to which real-time formative feedback, based on their strategy essays can improve students' problem-solving performance.

STUDY 2: *PROVIDING FEEDBACK ON STUDENTS' STRATEGY ESSAYS*

Lee, Y., Bralin, A., Rebello, N. S., & Goldwasser, D. (2026). Towards Just-in-Time Adaptive Feedback: Enhancing Student Learning via Knowledge-Grounded LLM. *arXiv preprint arXiv:2605.26405*.

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STUDY 2 : GOAL

- To address the challenge of providing real-time adaptive feedback at scale on students’ strategy essays.

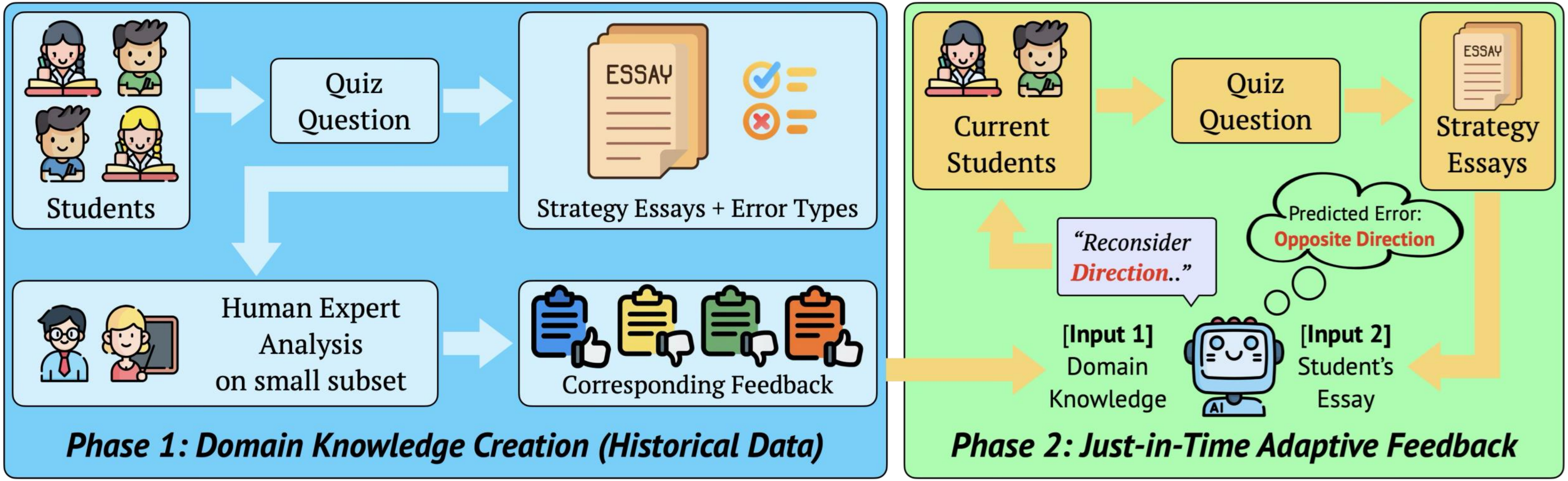
- Implementing a framework that provides Just-in-Time interventions using knowledge-grounded LLMs.

STUDY 2 : OVERALL FRAMEWORK

Just-in-Time Adaptive Feedback

<u>1st Phase</u>: We obtain domain knowledge from human experts regarding the appropriate feedback for students' strategy essays and the types of errors they made.

<u>2nd Phase</u>: At deployment, we ground the LLM with this knowledge and provide adaptive feedback to the students based on their written strategy essays.

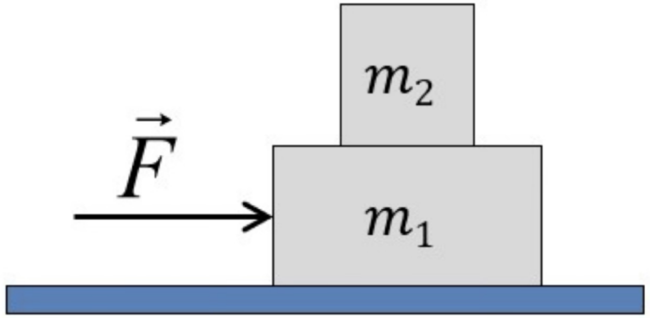


STUDY 2 : IMPLEMENTATION

Problem

A : Correct Answer
B : Misunderstanding force direction.
C : Ignoring position of where the force is applied.
D : Confusion regarding position and direction.

Quiz Problem



Question

What is the horizontal component of the force that top block exerts on the bottom block?

Answer Options

A. $-m_2 \frac{\vec{F}}{m_1 + m_2}$	B. $m_2 \frac{\vec{F}}{m_1 + m_2}$
C. $-m_1 \frac{\vec{F}}{m_1 + m_2}$	D. $m_1 \frac{\vec{F}}{m_1 + m_2}$

Example Feedback

Student

The only force that the top block will exert on the bottom block is the force of friction ... The acceleration of the top block equals the mass of the top block times the net force on both of the blocks divided by the total mass.

Good points! Just don't forget about the direction of the force that you find this way.

Expert

Even though the student gave the correct answer, the feedback mentions the importance of considering the direction of the force, which was missing in the essay.

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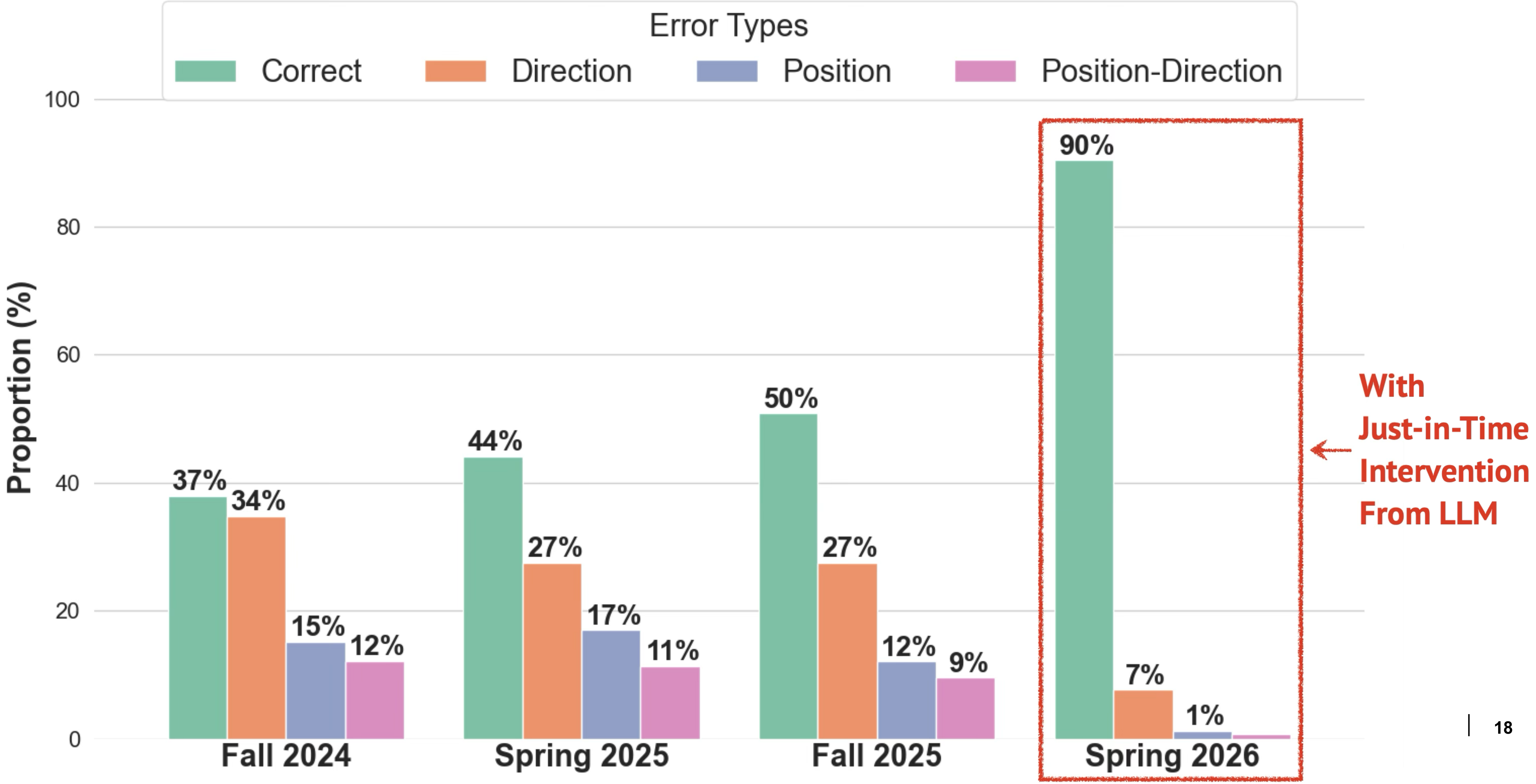
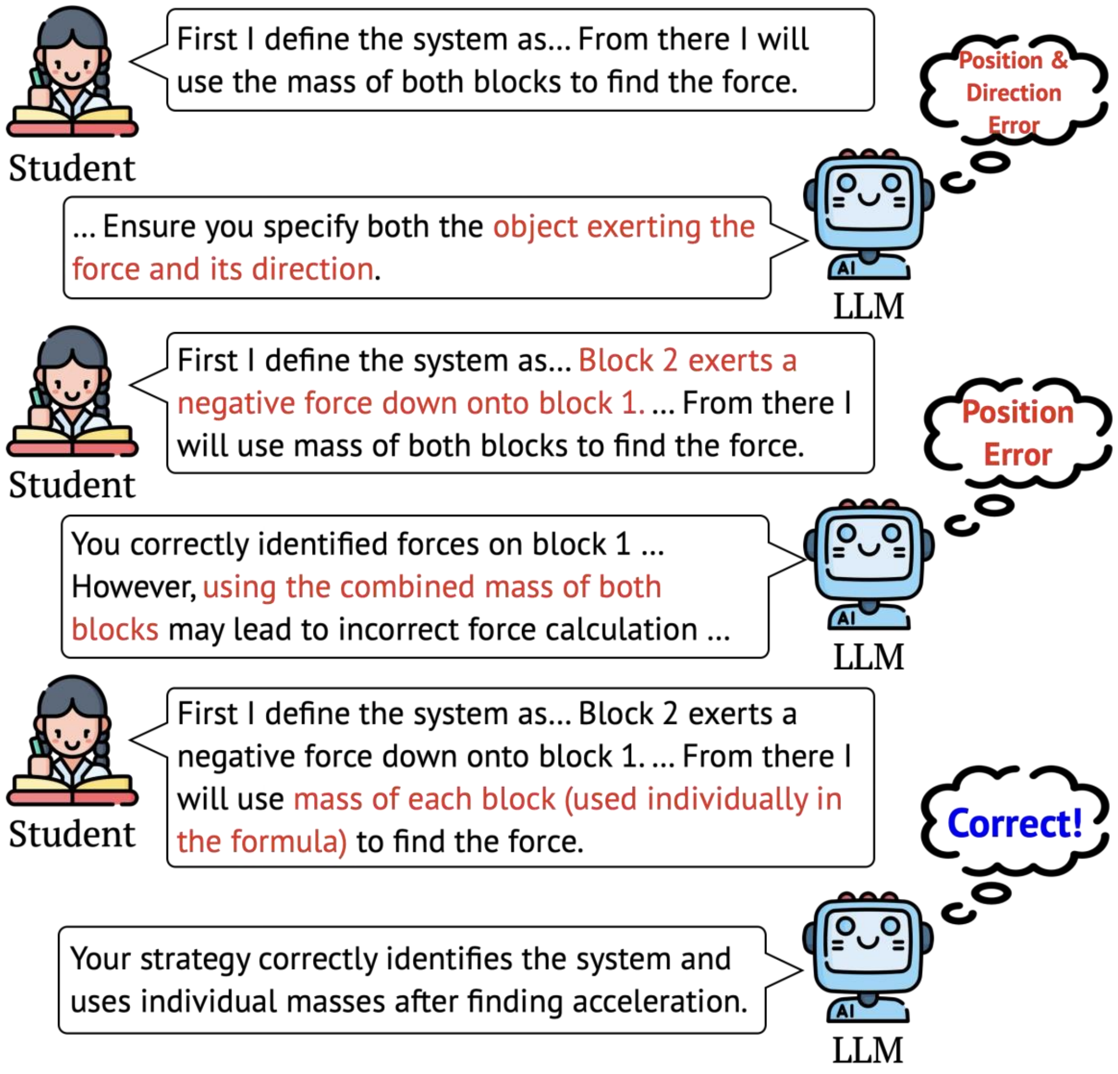
STUDY 2 : RESULTS



STUDY 2 : EMERGENT BEHAVIOR

Multiturn Conversations

- Student modifies their strategy essays with the help of LLM.
- LLM generates feedback based on its error type prediction and informs different aspects as the student fixes errors one by one.



Results

Metric	Value
Total Instances	1042
Conversational Instances	209 (20%)
Mean # Conversational Turns	2.77
% LLM Correct prediction of Multi-Choice Answer on 1st Turn	43%
% LLM Correct prediction of Multi-Choice Ans. on Last Turn	72%
% of Essays categorized by LLM as Correct after Multi-Turns	80%

STUDY 2 : CONCLUSIONS

- By analyzing strategy essays from students, our framework identifies potential errors and provides adaptive feedback grounded in domain knowledge.

- Our framework significantly improves the overall student performance by providing validation and guiding re-evaluation of incorrect concepts.

STUDY 2 : LIMITATIONS

- LLM currently does not consider students' knowledge level : Currently feedback is constructed assuming low prior knowledge.
- LLM feedback falls into a catastrophic failing mode when the LLM incorrectly classifies an essay as 'correct' and does not provide necessary interventions.
- Predicting error types solely from strategy essays is a non-trivial task even for humans. Students often omit important details, whether due to oversight or lack of conceptual understanding.
- Small number of Just-in-Time interventions, as the framework was applied to only a single quiz during the semester, a broader deployment across multiple topics and quiz types is necessary to validate these findings.

DISCUSSION QUESTIONS

DISCUSSION QUESTIONS

1. Where did AI push our thinking about theory? Did your tool reveal something about learning, cognition, or instruction that our original theoretical framework didn't fully account for?
2. What was the hardest ethical or methodological decision we had to make around bias, transparency, or data use? How did we handle it in practice, and what would we do differently now?
3. How did the specific role of AI in our project (student-facing vs. teacher-facing) shape your research design and the kinds of claims you could make? What could you study because of that choice? What did it limit?
4. What do we think made it compelling to NSF as fundamental research? What aspects of our proposal signaled theory-building rather than just tool development or application?
5. As our project has unfolded, how have we had to adapt to the pace of change in AI? What have we done to keep our work theoretically grounded while the technology itself keeps shifting?

QUESTION 1: ROLE OF THEORY

- Where did AI push our thinking about theory? Did your tool reveal something about learning, cognition, or instruction that our original theoretical framework didn't fully account for?
  - Project was based on and it also reinforced the already well accepted 'knowledge in pieces' theory about student knowledge and reasoning.

QUESTION 2: ETHICS & METHODS

- What was the hardest ethical or methodological decision we had to make around bias, transparency, or data use? How did we handle it in practice, and what would we do differently now?
  - The task shown was an 'extra-credit' task and points were given for participation not correctness.
  - Participants were informed that the feedback was AI generated and they should not trust it blindly.
  - We avoided feeding student-sensitive information to any of the LLM user interfaces such as ChatGPT.
    - However, in future if we need to associate student use of our tool their prior knowledge and academic preparation, we need to rely on a locally running model.

QUESTION 3: STUDENT vs. TEACHER

- How did the specific role of AI in our project (student-facing vs. teacher-facing) shape your research design and the kinds of claims you could make? What could you study because of that choice? What did it limit?
  - The role of AI in the project was student-facing and interactive. We set it up so that an LLM provides short feedback to students' strategies for solving the quiz problem.
  - We had to make sure that students interactions with the LLM were appropriate and did not constitute cheating. So, we first prompted the model to never give out the correct answer but only provide some hints based on the strategies and common mistakes students make.

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QUESTION 4: TYPE OF RESEARCH

- What do we think made it compelling to NSF as fundamental research? What aspects of our proposal signaled theory-building rather than just tool development or application?
  - Not certain that this project qualifies as ‘fundamental research’. It is grounded in prior empirical research which shows that strategy writing, and feedback on student generated strategies can improve problem-solving.

QUESTION 5: CHANGING AI

- As our project has unfolded, how have we had to adapt to the pace of change in AI? What have we done to keep our work theoretically grounded while the technology itself keeps shifting?
  - Whenever we made some claims about the accuracy or reliability of AI-feedback, we ran a risk of underestimating the newer model's capabilities on the same tasks.
  - So, we used problem-solving tasks that did not show easy gains in accuracy/reliability due to newer models being released.
  - Even with the state-of-the-art models, we have found that there is room for improvement in feedback generated by the model.

THANK YOU

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"I don't want to be a ***basketball player****,*
but the social media keeps recommending me basketball content."

Towards Embodied Learning fo
K-12 Machine Learning Education

Zhen Bai

Assistant Professor

Computer Science, University of Rochester

ECR PI Meeting, June 30th, 2026

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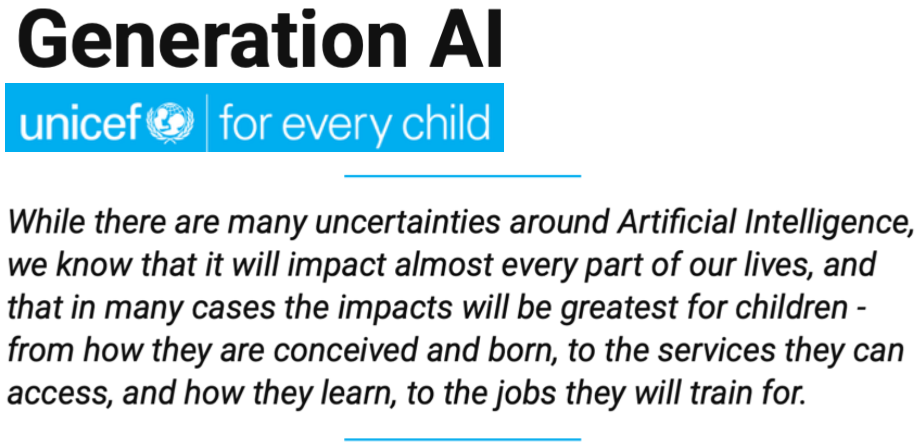
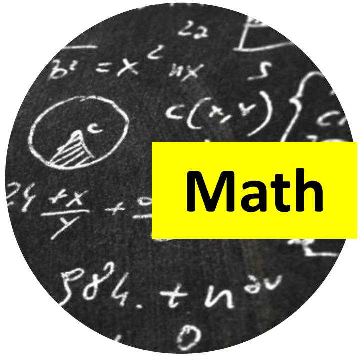
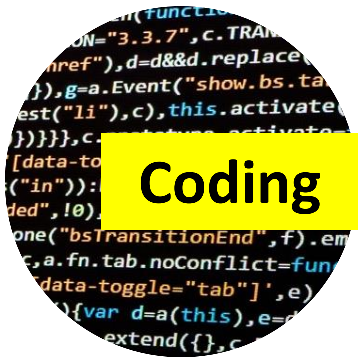
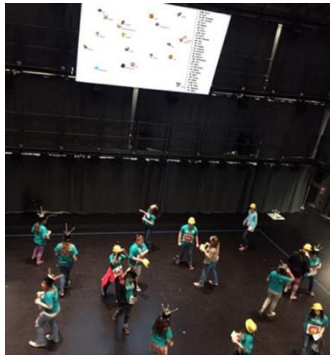
Award No. 2238675



How can we demystify AI for children?







Bodily data vis (Chen et al., 2017)

Balance Board Math (Tancredi et al., 2022)

Draw2code (Im & Rogers, 2021)

Can embodied learning support student to understand AI's inner workings?

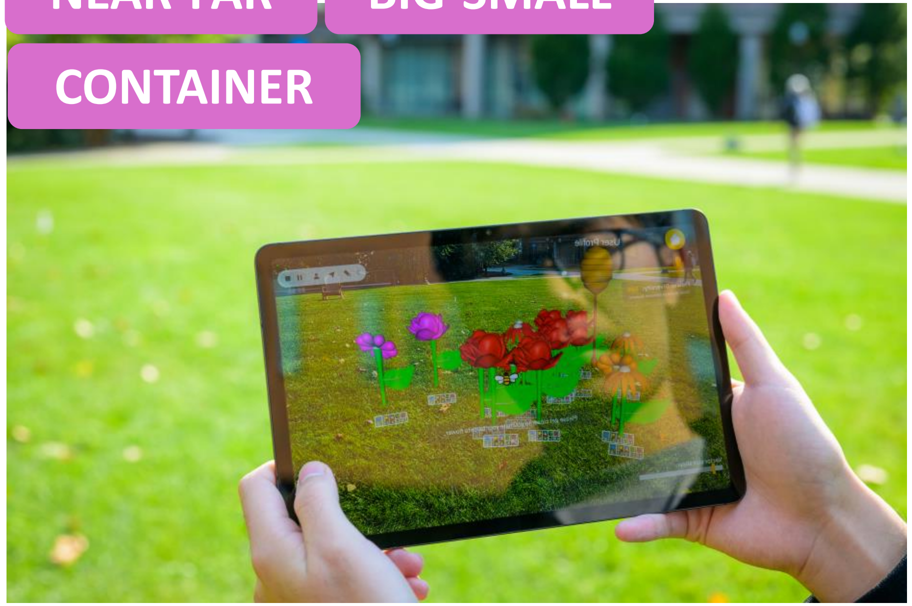
Embodied Metaphor

Unfamiliar abstract concepts

AI Recommendation

Familiar sensorimotor experience

NEAR-FAR BIG-SMALL CONTAINER

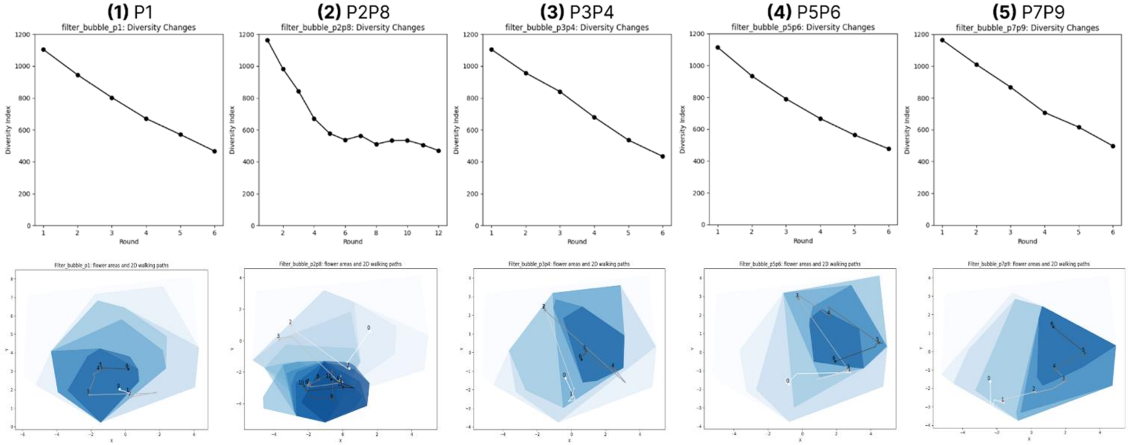


BeeTrap

DARK-BRIGHT BLOCKAGE MERGE HUE

Briteller

Embodied Learning Experience



BeeTrap

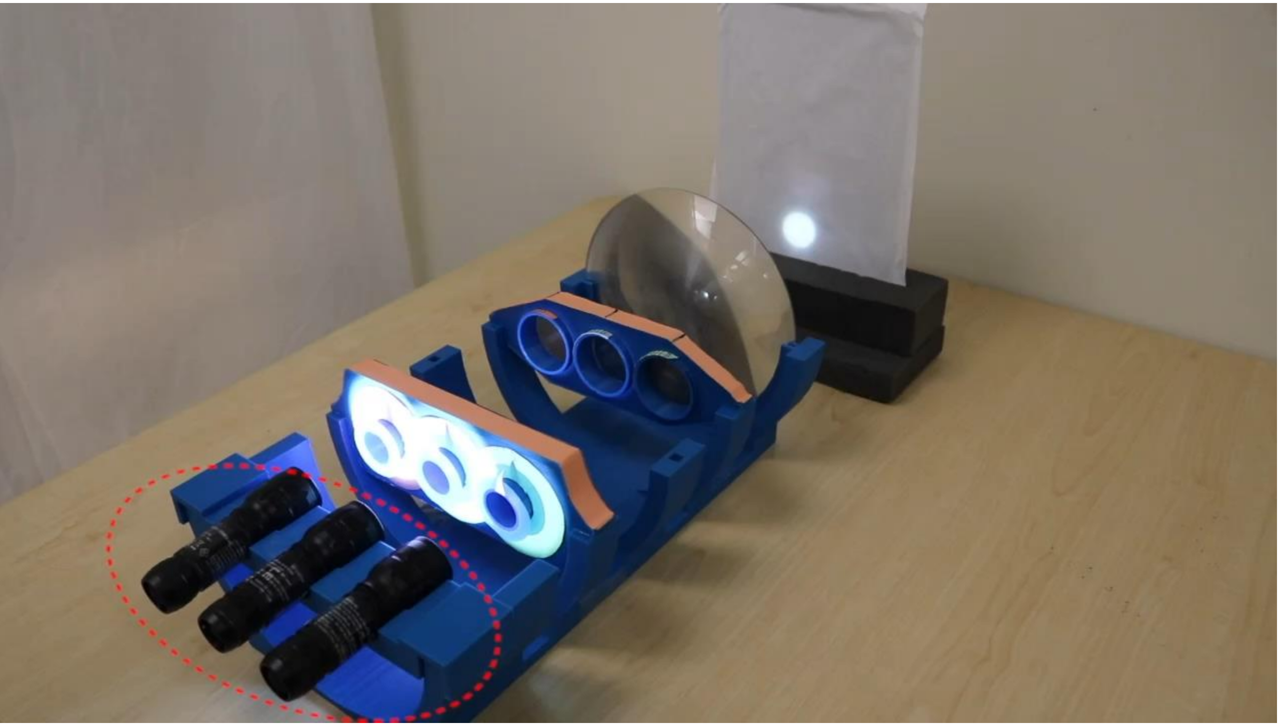
"I don't want to be a ***basketball player****, but the social media keeps recommending me basketball content."*

Zhou et al. (2024, June). " Bee and I need diversity!" Break Filter Bubbles in Recommendation Systems through Embodied AI Learning. IDC 2024.
Gong et al. (2024, June). Approaching "Filter Bubble" in Recommendation Systems: A Transformative AI Literacy Learning Experience. ISLS 2024.

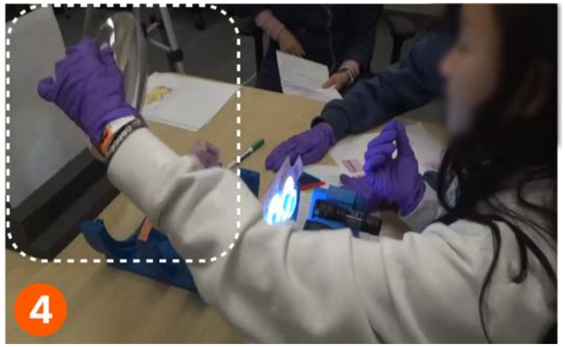
The Dot Product Definition

$$\mathbf{a} = \langle a_1, a_2, a_3 \rangle \quad \mathbf{b} = \langle b_1, b_2, b_3 \rangle$$

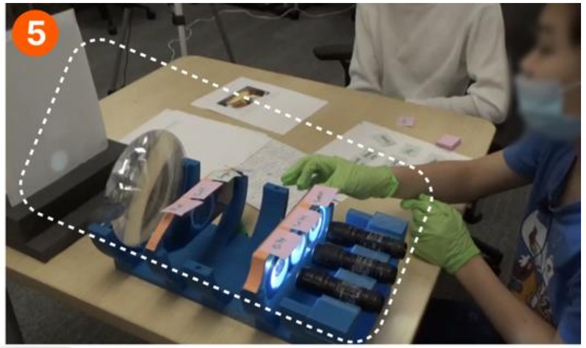
$$\boxed{\mathbf{a} \cdot \mathbf{b} = a_1 b_1 + a_2 b_2 + a_3 b_3}$$



Briteller



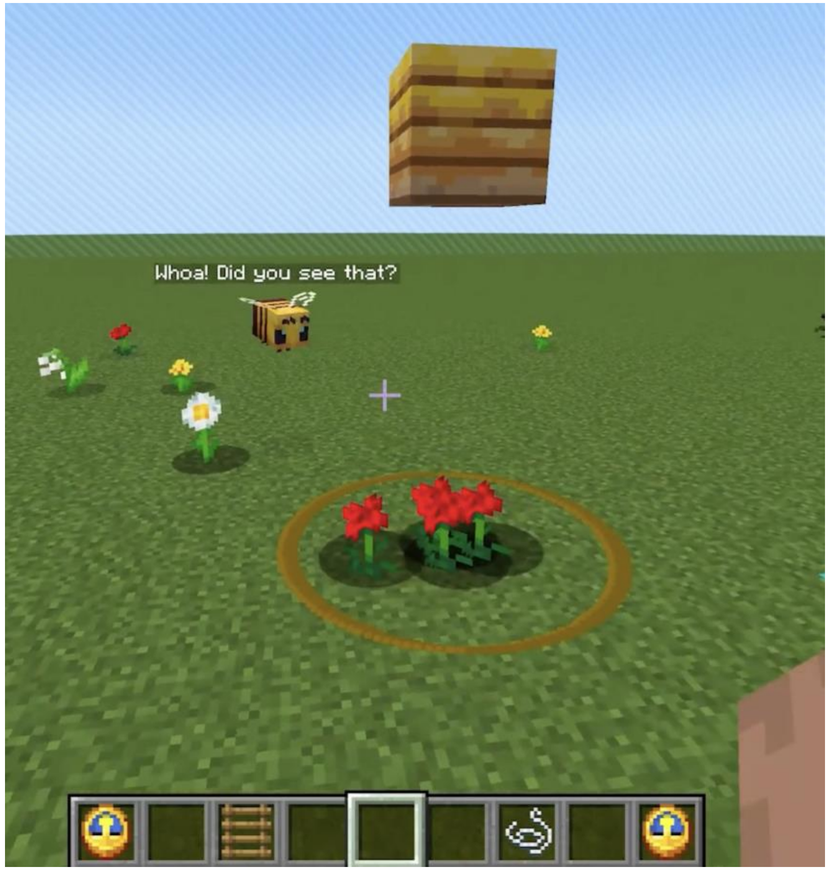
"The scales (of the knobs) are **multiplied together**—the light goes through this (set of knobs) and then this (set of knobs). Each time it blocks part of the light. "



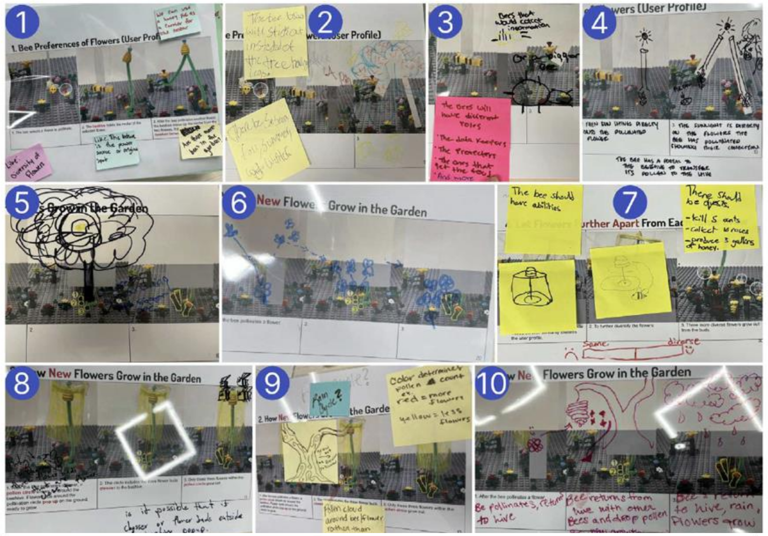
"The result is zero. But one plus zero is one. So, **it's not an addition. It's multiplication.**"

Zhou et al. (2025, April). Briteller: Shining a Light on AI Recommendations for Children. CHI 2025.

Embodied AI @Scale

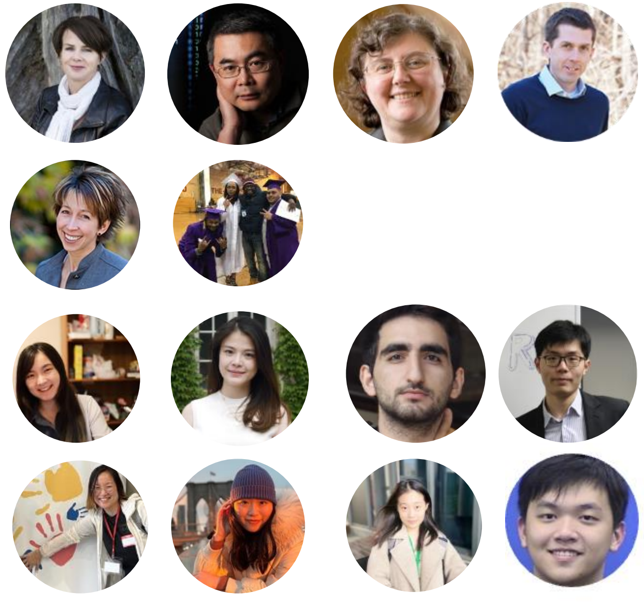


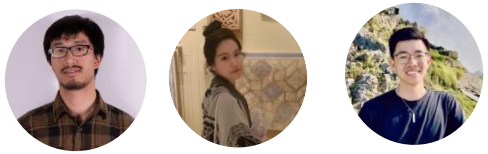
Learner-as-Designer



Example Analogy (target concept, analogy)

6 years old, likes toys and cartoons like Peppa Pig	9 years old, likes drawing and comic book, good at art	16 years old, likes science and physics
Imagine the Solar System as a big, colorful carousel at the fair. The Sun is the tall pole in the middle, holding everything together, and each planet is like a fun horse that goes around and around. Mercury is the horse closet to the pole, and Neptune is way out on the edge. Each horse has a different color and style, just like each planet is special – Mars is red, Saturn has rings, and Uranus spins a little sideways! All the planets keep spinning around the Sun in a big circle, just like carousel horses moving together in a magical ride.	Imagine the Solar System as a vast comic book series, where each planet is a unique character with its own story and personality, and plays a specific part in the cosmic story. The Sun, as the central figure, is the superhero that holds everything together. The rocky planets, like Mercury and Mars, are the adventurous sidekicks... The gas giants, such as Jupiter and Saturn, are the powerful allies... The ice giants, Uranus and Neptune, add mystery and intrigue... Finally, the dwarf planets and the Kuiper Belt are the hidden gems	Imagine the Solar System as a giant atom. At its center, the Sun acts like the nucleus - a massive body that holds the system together.... Just as the nucleus is the dense core of an atom, the sun is the central powerhouse of the Solar System. Surrounding the Sun are the planets, akin to electrons orbiting the nucleus. These planets follow specific paths just like orbits, maintaining a delicate balance between the forces pulling them inward and those propelling them outward.





and many...

Zhou et al. (2025). Co-design of analogical and embodied representations with children for child-centered AI learning experiences. International Journal of Human-Computer Studies.
Zhou et al. (2025). Design AI for My Community: A Case Study of Collaborative Learning in a Freedom-to-Read Summer Camp. ISLS 2025.
Wu et al. (2025, July) AGen: Personalized Analogy Generation through Large Language Model. AIED 2025.
Farhadi et al. Meet Bip: Understanding Student–Peer Agent Interaction in an Embodied Exploratory Learning Environment. CSCL 2026.
Farhadi et al. (2026, January). Beetrap-MC: A Minecraft-Based AI Literacy Tool for Teaching Filter Bubbles to Middle School Students. EAAI'26.

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