

Questioning Intelligence: Building Things Better, or Building Better Things?

AI-Powered Materials Discovery Workshop Plenary
June 23rd, 2025

Katherine Moore

The US Education System (in a nutshell)

The US Education System

- teacher burnout

44%

K-12 Teachers

Burned out
frequently

30%

**All Other
Workers**

Average burnout
rate

55%

**Female
Teachers**

Highest burnout
group

14%

Point Gap

Above average
worker

Source: <https://news.gallup.com/poll/393500/workers-highest-burnout-rate.aspx>

The US Education System

- teacher burnout
- increasing cultural and linguistic diversity

Sources:

- 2020 Census Data
- <https://www.socialworkers.org/Practice/NASW-Practice-Standards-Guidelines/Standards-and-Indicators-for-Cultural-Competence-in-Social-Work-Practice>
- <https://nccc.georgetown.edu/foundations/need.php>

42%

Non-White Population

Nearly 4 in 10 Americans
(2020)

50%

Youth Diversity

Under 18 population is non-
White

The US Education System

- teacher burnout
- increasing cultural and linguistic diversity
- increasing needs for special education

Sources:

- <https://www.disabilityscoop.com/2024/06/25/special-education-enrollment-hits-all-time-high/30935/>
- <https://nces.ed.gov/programs/coe/indicator/cgg/students-with-disabilities>

7.5M

Students Served
2022-2023 School Year

15%

Of All Students
Up from 13% in 2012-13

+1.1M

Growth Since 2012
17% Increase

The US Education System

- teacher burnout
- increasing cultural and linguistic diversity
- increasing needs for special education
- decreased funding for teacher PD

Sources:

- <https://southdakotasearchlight.com/2025/04/10/state-cancels-teacher-trainings-for-new-social-studies-standards-due-to-federal-funding-cuts/>
- <https://southdakotasearchlight.com/2025/04/18/south-dakota-turned-to-paraprofessionals-to-attack-a-teacher-shortage-and-hundreds-responded/>

\$600M+

**Federal Grants
Terminated**

Teacher Training Programs Cut

\$58,178

South Dakota Loss

Teacher Apprenticeship Program

350+

SD Teacher Vacancies

July 2024 (Up from 174 in 2021)

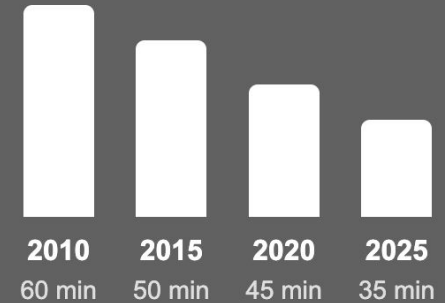
The US Education System

- teacher burnout
- increasing cultural and linguistic diversity
- increasing needs for special education
- decreased funding for teacher PD
- decreasing time for teacher prep periods

Sources:

- <https://edsources.org/2025/teachers-need-more-prep-time/729793>
- <https://www.causinglearning.com/blog/prep-time-a-mismanaged-resource-and-professional-bone-of-contention/>

Historical Trend: Average Daily Prep Time



* Figure depicts an illustrative trend based on reported patterns, not from comprehensive longitudinal surveys

The US Education System (in a nutshell)

- teacher burnout
- increasing cultural and linguistic diversity
- increasing needs for special education
- decreased funding for teacher PD
- decreasing time for teacher prep periods
- funding trends suggest a decrease in 1:1 and small group support

The US Education System (in a nutshell)

- teacher burnout
- increasing cultural and linguistic diversity
- increasing needs for special education
- decreased funding for teacher education
- decreasing time for teacher preparation
- funding trends suggest that

The need...

We need technology to retain teachers and offer specialized support

AI in Education (in the U.S.)



50%

of US teachers
used chatGPT
within 3 months
of its release

November, 2022

AI in Education (in the U.S.)



50%



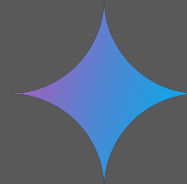
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November, 2022

of US teachers
use a generic
generative AI
(GAI) tool

today



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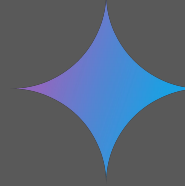
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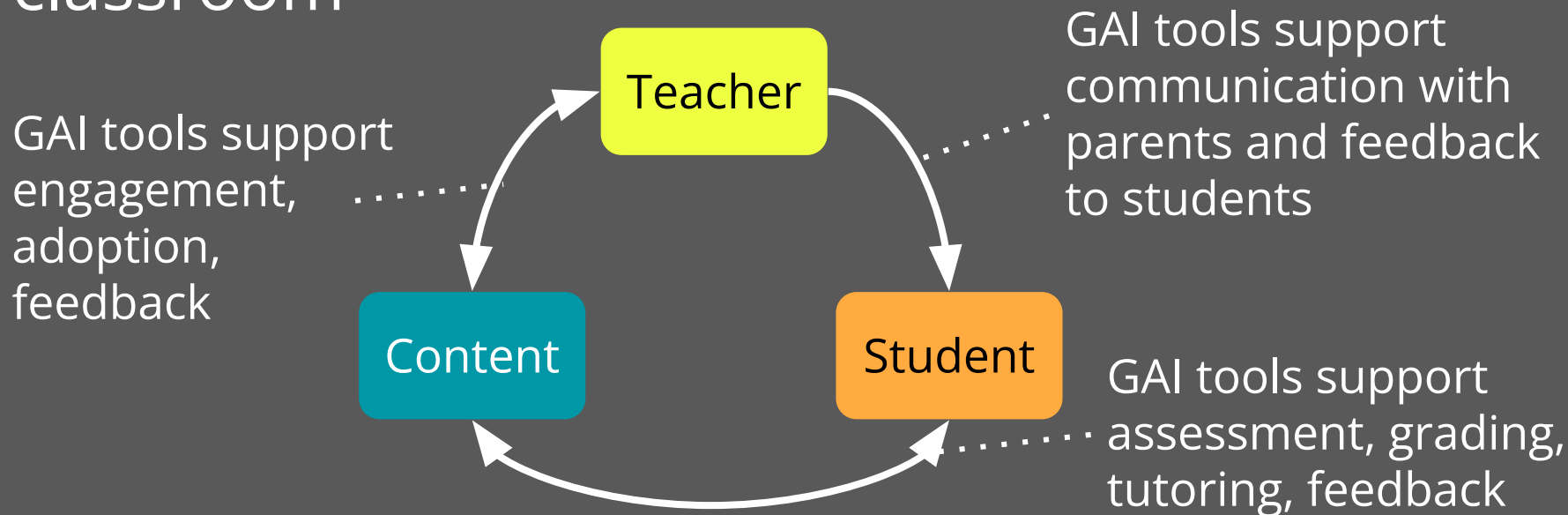
November, 2022

of US teachers
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AI powered solutions have already entered the classroom



Original concept from Professor Min Sun at the College of Education, University of Washington

Questioning Intelligence: Building Things Better, or Building Better Things?

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Goals of this Talk

- Compare accelerated discovery vs. impacts on human intelligence
- Introduce challenges to AI education and teacher preparedness
- Spark dialogue about innovative applications of AI for education

Flow of Topics

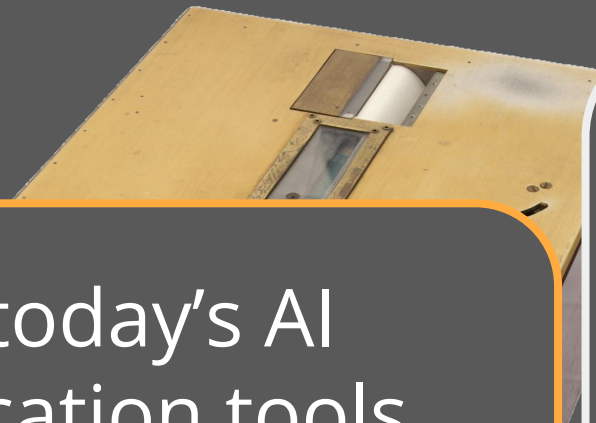
- The promise of teaching machines
- Teaching with AI
- Learning with AI
- AI literacy
- The future of AI in education
- Closing remarks



The Promise of Teaching Machines



“If the teacher is to take advantage of recent advances in the study of learning, she must have the help of mechanical devices.”
B.F. Skinner

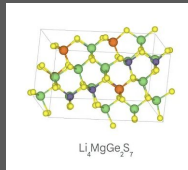
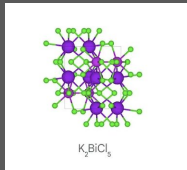


Are today's AI
education tools
any different?
(They better be!)

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AI improves efficiency in Materials Science

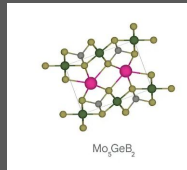
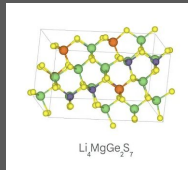
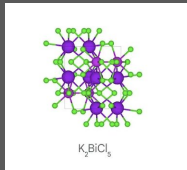
Efficiency in Materials Science



Source:
<https://deepmind.google/discover/blog/millions-of-new-materials-discovered-with-deep-learning/>

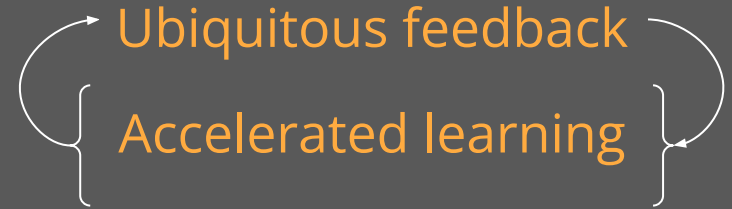
AI improves efficiency in Materials Science & Education

Efficiency in Materials Science



Source:
<https://deepmind.google/discover/blog/millions-of-new-materials-discovered-with-deep-learning/>

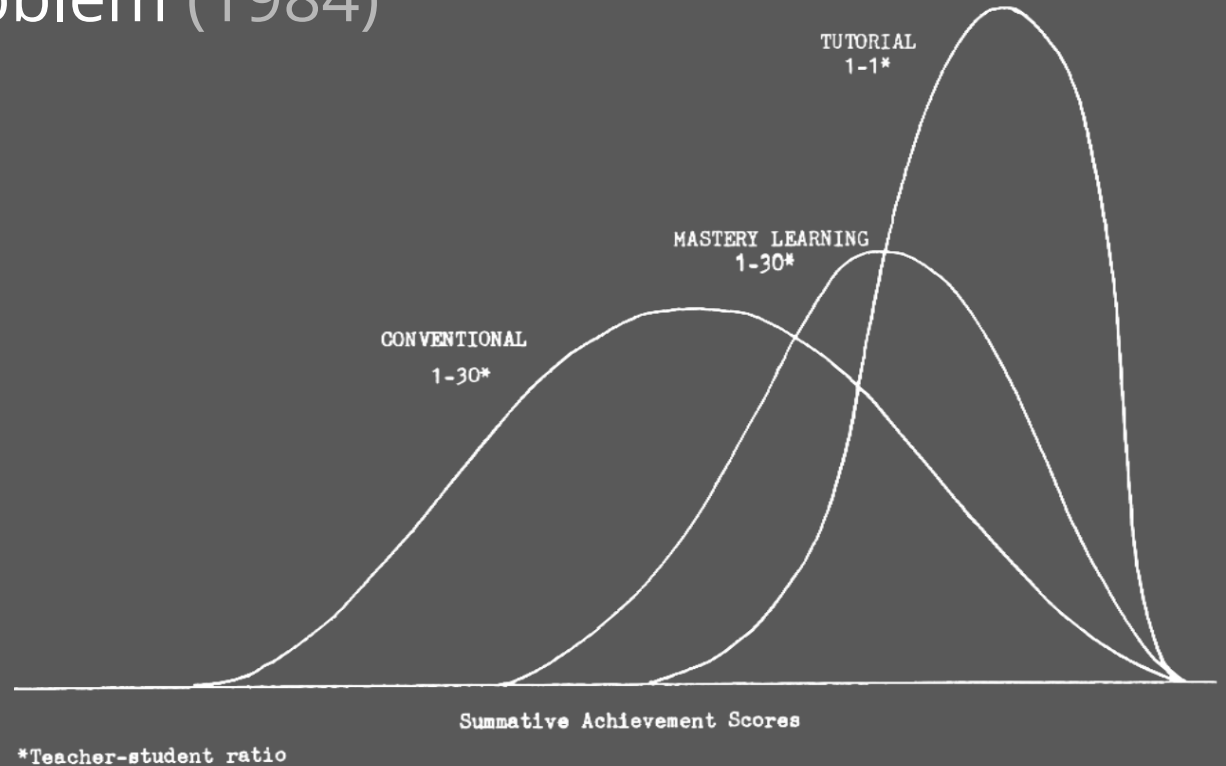
Efficiency in Education



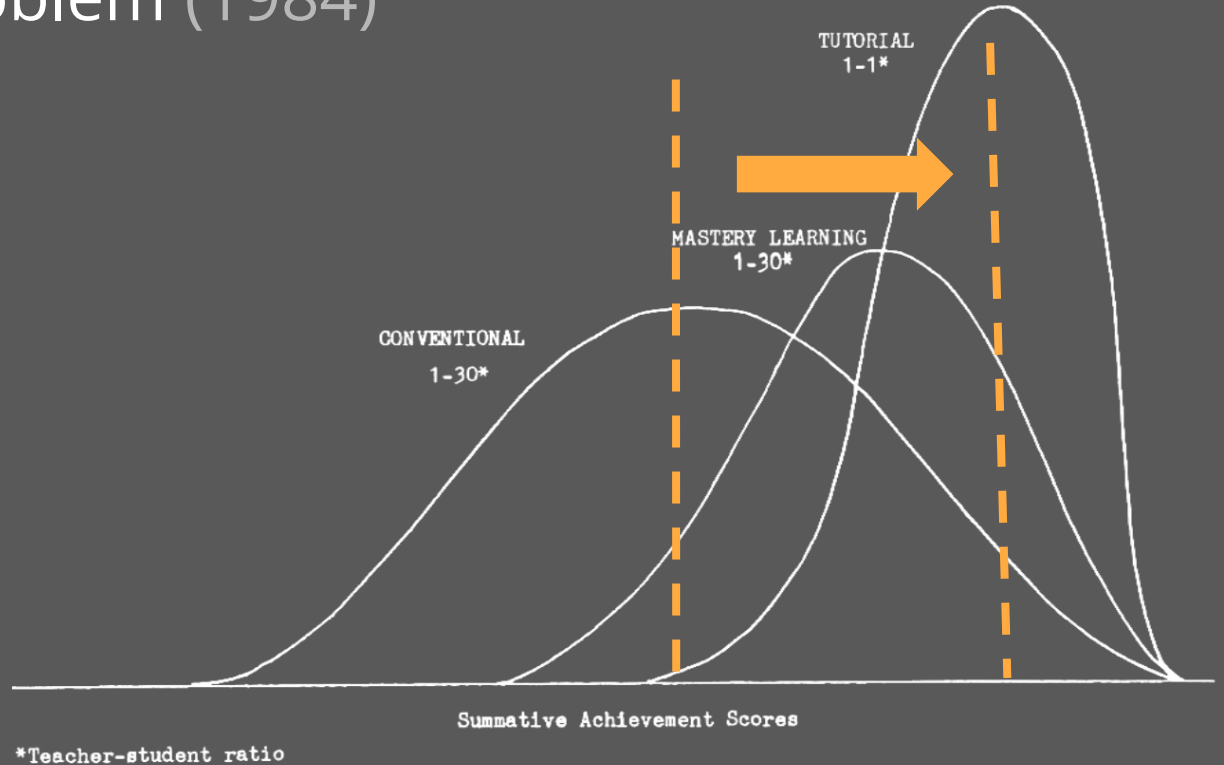
Source: <https://hyperspace.mv/learning-styles-ai/>

The 2 sigma problem (1984)

Reference: Bloom, B. S. (1984). The 2 sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. Educational researcher, 13(6), 4-16.

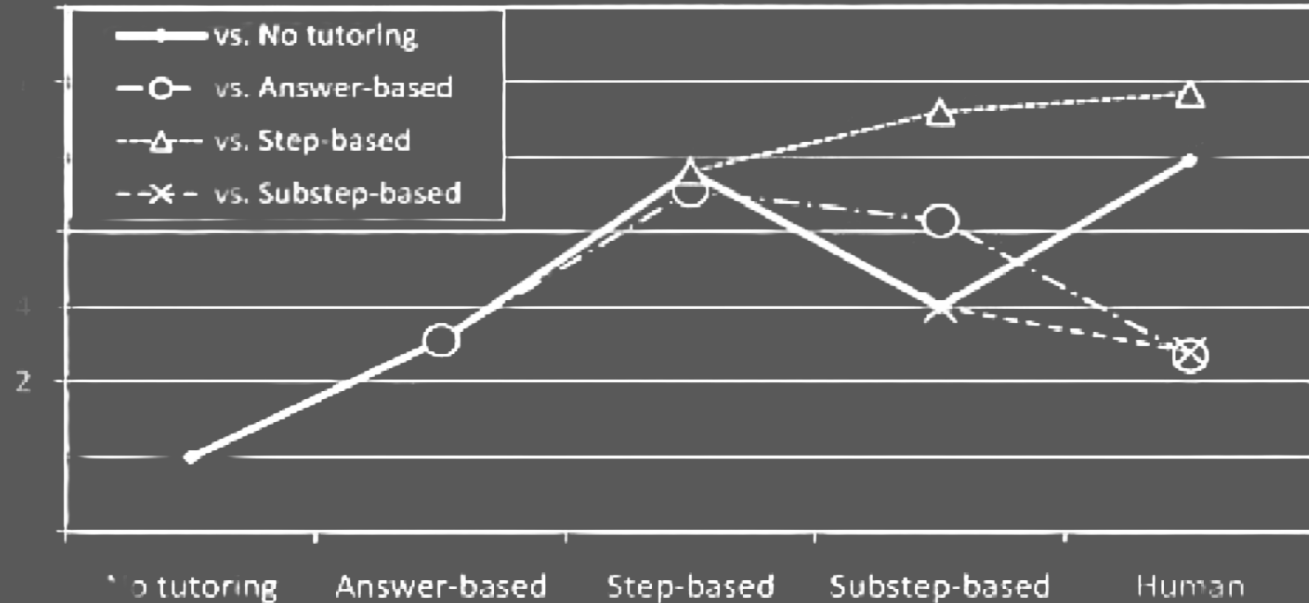


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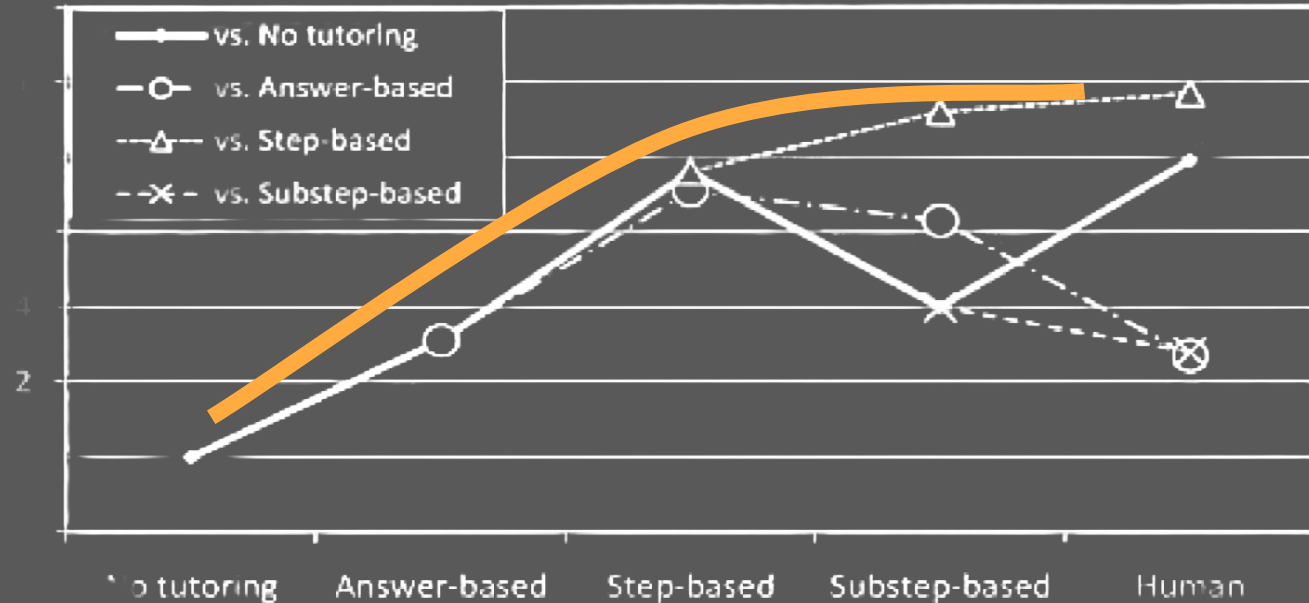
Fallacy of the 2 sigma problem (2011)

Interaction plateau hypothesis



Reference: VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational psychologist*, 46(4), 197-221.

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Is AI an efficiency tool for teachers?

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- Does faster production of lesson plans lead to better lesson plans?



Created by Yoleyo
from Noun Project

Is AI an efficiency tool for teachers?

- Does faster production of lesson plans lead to better lesson plans?
- What is the cognitive work that AI is alleviating for teachers to help them do their jobs better?



Created by Yoleyo
from Noun Project



Created by Meaghan Hendricks
from Noun Project

Is AI an efficiency tool for teachers?

- Does faster production of lesson plans lead to better lesson plans?
- What is the cognitive work that AI is alleviating for teachers to help them do their jobs better?
- Is AI really saving time for teachers? Might it actually take more time to learn to use it well?



Created by Yoleyo
from Noun Project



Created by Meaghan Hendricks
from Noun Project



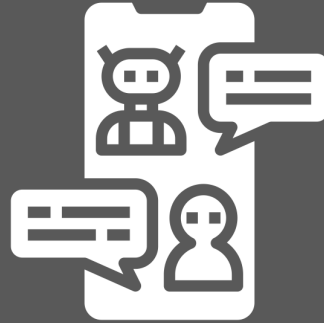
Created by Gregor Cresnar
from Noun Project

Educators augmenting their teaching with AI



Created by Puspa Kusuma
from Noun Project

Differentiation



Created by monkik
from Noun Project

Ideation



Created by Icon From Us
from Noun Project

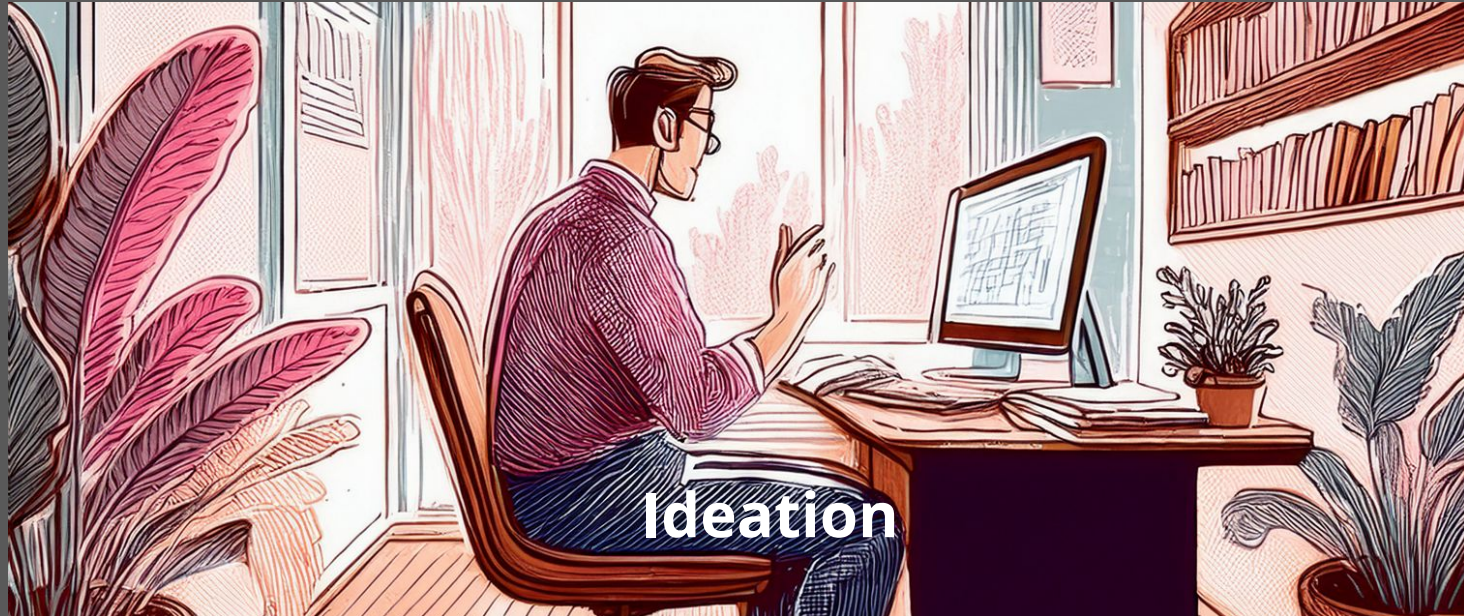
Engagement

Educators augmenting their teaching with AI



Differentiation

Educators augmenting their teaching with AI



Educators augmenting their teaching with AI



Educators augmenting their teaching with AI



Differentiation



Ideation



Engagement

The 3rd Agent



The 3rd Agent



The 3rd Agent



Learning with LLM-based cognitive tutors to advance one's learning has mixed effects.

Positive Effects

Negative Effects

Effects on Cognition

- academic achievement
- higher-order thinking

- transfer learning
- critical thinking skills

Effects on Affective Learning

- enjoyment, less tension
- self-efficacy
- motivation

- inflated beliefs about one's knowledge and abilities
- interpersonal relationships

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“The application of ChatGPT in education significantly reduced students' mental effort, making learning less cognitively demanding.”

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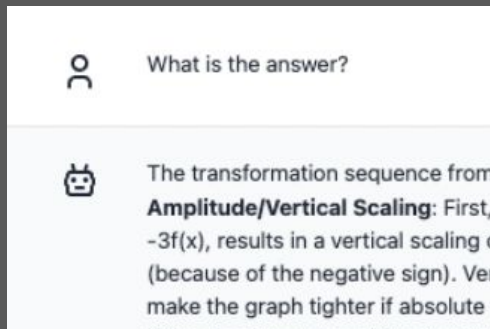
- enjoyment, less tension
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“chatGPT tutors can decrease transfer learning”

Describe, in order, a sequence of transformations that maps the graph of $y = f(x)$ onto the graph $y = -3f(x) + 2$.

A.

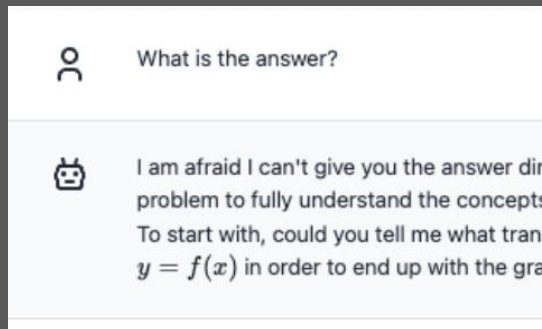


What is the answer?

The transformation sequence from $y = f(x)$ to $y = -3f(x) + 2$ involves the following steps:

Amplitude/Vertical Scaling: First, the graph is vertically stretched by a factor of 3, resulting in $y = 3f(x)$. Then, it is reflected across the x-axis (because of the negative sign), resulting in $y = -3f(x)$. Finally, the graph is shifted vertically upwards by 2 units, resulting in $y = -3f(x) + 2$.

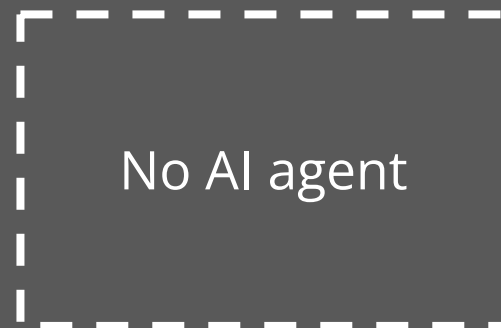
B.



What is the answer?

I am afraid I can't give you the answer directly because I don't have enough context to fully understand the concepts involved in the problem. To start with, could you tell me what transformations you are referring to? For example, are you talking about the graph of $y = f(x)$ in order to end up with the graph of $y = -3f(x) + 2$?

C.



Reference: Bastani, H., Bastani, O., Sungu, A., Ge, H., Kabakçı, O., & Mariman, R. (2024). Generative ai can harm learning. Available at SSRN, 4895486.

The Promise of Teaching Machines



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“chatGPT tutors increase inflated beliefs about one’s knowledge”

Table 13 The Effect of LLM Usage on Perceived Learning.

<i>Treatment (LLM access = 1)</i>	<i>Perceived Learning</i>	
	(1)	(2)
<i>Treatment (LLM access = 1)</i>	0.338** (0.166)	0.348** (0.170)
<i>Post-test – Pre-test</i>	0.128 (0.164)	0.140 (0.170)
<i>Level of Studies</i>	0.154*** (0.024)	0.162*** (0.035)
<i>LLM Used Before (yes = 1)</i>	-0.079 (0.171)	-0.071 (0.174)
<i>Python Experience</i>	-0.079 (0.116)	-0.077 (0.117)
<i>Studiousness</i>	-0.192 (0.140)	-0.198 (0.142)
<i>LLM Used Before (yes = 1)</i>	-0.194** (0.091)	-0.197** (0.092)
<i>LLM Experience</i>	0.086 (0.138)	0.083 (0.139)
<i>Pre-test</i>	-0.101 (0.166)	-0.102 (0.166)
<i>Learning Phase</i>	0.052 (0.057)	0.053 (0.057)
<i>Constant</i>	-0.672*** (0.246)	-0.678*** (0.247)
Observations	176	176
R ²	0.336	0.336
Adjusted R ²	0.283	0.278

Notes. Regressions include subjects from Studies 2 and 3. Standard errors are in parenthesis. *: $p < 0.1$; **: $p < 0.05$; ***: $p < 0.01$.

Reference: Lehmann, M., Cornelius, P. B., & Sting, F. J. (2024). AI meets the classroom: When does ChatGPT harm learning?. Available at SSRN 4941259.

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Constrained Agency with GAI



Intervening when attention wanders

Just-in-time tutoring

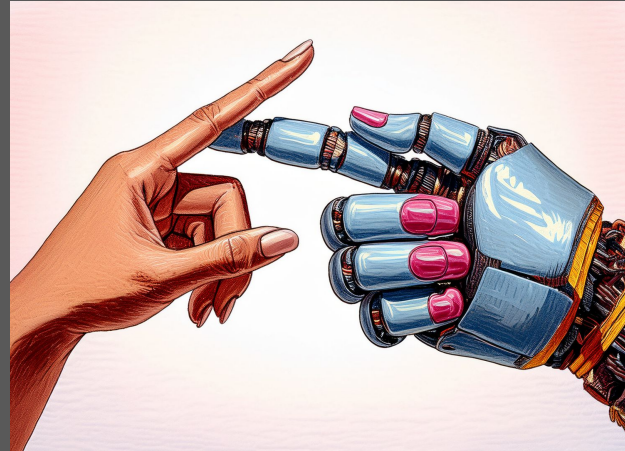
Reference: Resnick, M. (2024). Generative AI and creative learning: Concerns, opportunities, and choices. An MIT Exploration of Generative AI, March. <https://doi.org/10.21428/e4baedd9.cf3e35e5>

Collaborative Problem Solving with GAI

Pros



Cons



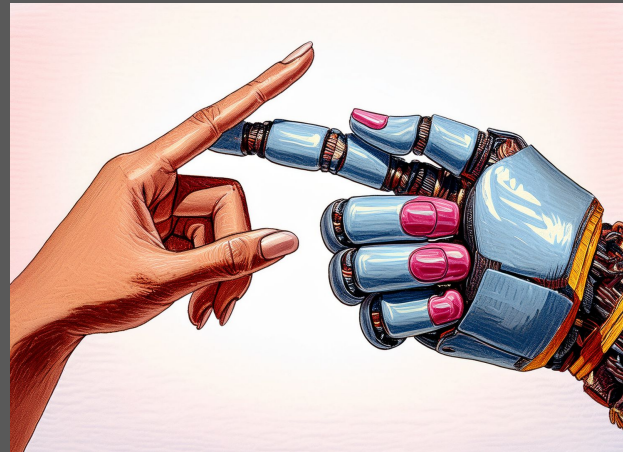
Reference: Wei, X., Wang, L., Lee, L.-K., & Liu, R. (2025). The Effects of Generative AI on Collaborative Problem-solving and Team Creativity Performance in Digital Story Creation: an experimental study. *International Journal of Educational Technology in Higher Education*, 22:23. <https://doi.org/10.1186/s41239-025-00526-0>

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Collaborative Problem Solving with GAI

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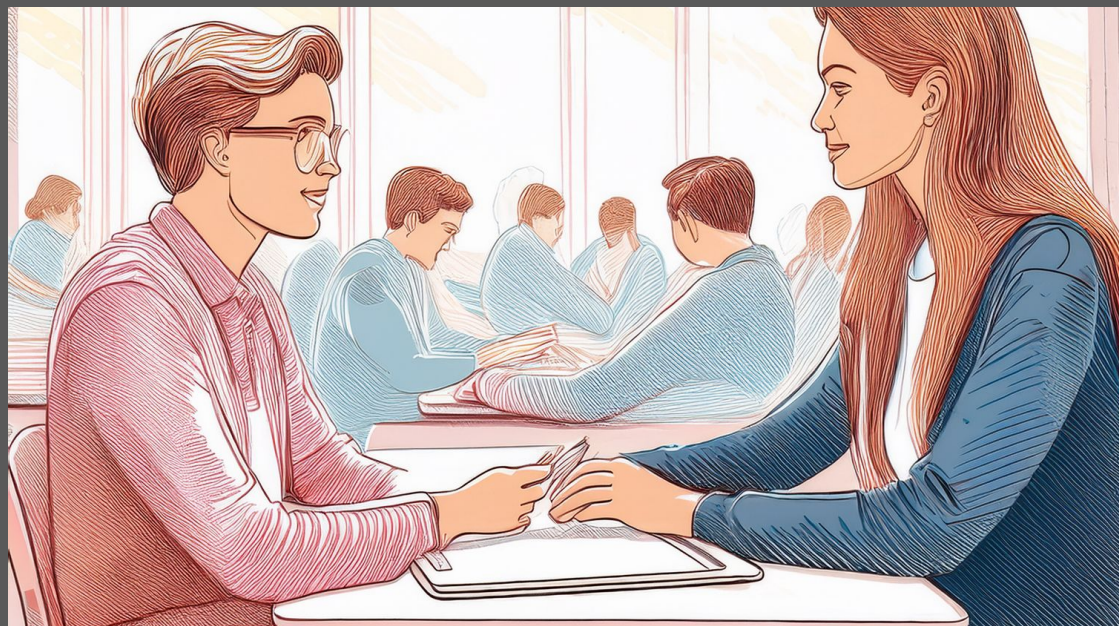


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Reference: Wei, X., Wang, L., Lee, L.-K., & Liu, R. (2025). The Effects of Generative AI on Collaborative Problem-solving and Team Creativity Performance in Digital Story Creation: an experimental study. *International Journal of Educational Technology in Higher Education*, 22:23. <https://doi.org/10.1186/s41239-025-00526-0>

Question Intelligence



Teen Girls Confront an Epidemic of Deepfake Nudes in Schools

Using artificial intelligence, middle and high school students have fabricated explicit images of female classmates and shared the doctored pictures.



Reference:

Singer, N. (2024). Teen Girls Confront an Epidemic of Deepfake Nudes in Schools.

<https://www.nytimes.com/2024/04/08/technology/deepfake-ai-nudes-westfield-high-school.html>

Learning with AI



Reference:
Singer, N. (2023). At This School, Computer Science Class Now Includes Critiquing Chatbots
<https://www.nytimes.com/2023/02/06/technology/chatgpt-schools-teachers-ai-ethics.html>

AI Literacy
enables students and teachers
to apply critical thinking

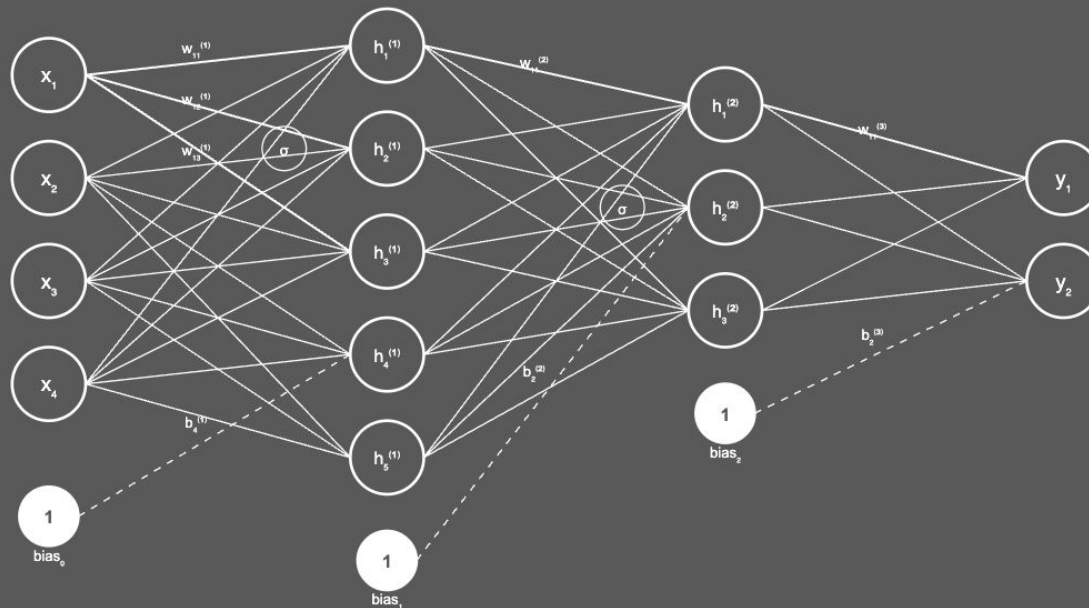
AI Literacy

enables students and teachers
to apply critical thinking to
identify affordances and
potential biases of AI,

AI Literacy

enables students and teachers
to apply critical thinking to
identify affordances and
potential biases of AI,
and decide whether AI outputs
are trustworthy and
appropriate.

Input Layer Hidden Layer 1 Hidden Layer 2 Output Layer



Mathematical Formulation:

Hidden Layer 1: $h^{(1)} = \sigma(W^{(1)}x + b^{(1)})$

Hidden Layer 2: $h^{(2)} = \sigma(W^{(2)}h^{(1)} + b^{(2)})$

Output Layer: $y = W^{(3)}h^{(2)} + b^{(3)}$

Activation Function: $\sigma(z) = 1/(1 + e^{-z})$ or $\text{ReLU}(z) = \max(0, z)$

Weight Matrix Example:

$$W^{(1)} = \begin{bmatrix} w_{11}^{(1)} & w_{12}^{(1)} & w_{13}^{(1)} & w_{14}^{(1)} \\ w_{21}^{(1)} & w_{22}^{(1)} & w_{23}^{(1)} & w_{24}^{(1)} \\ w_{31}^{(1)} & w_{32}^{(1)} & w_{33}^{(1)} & w_{34}^{(1)} \\ w_{41}^{(1)} & w_{42}^{(1)} & w_{43}^{(1)} & w_{44}^{(1)} \end{bmatrix}$$

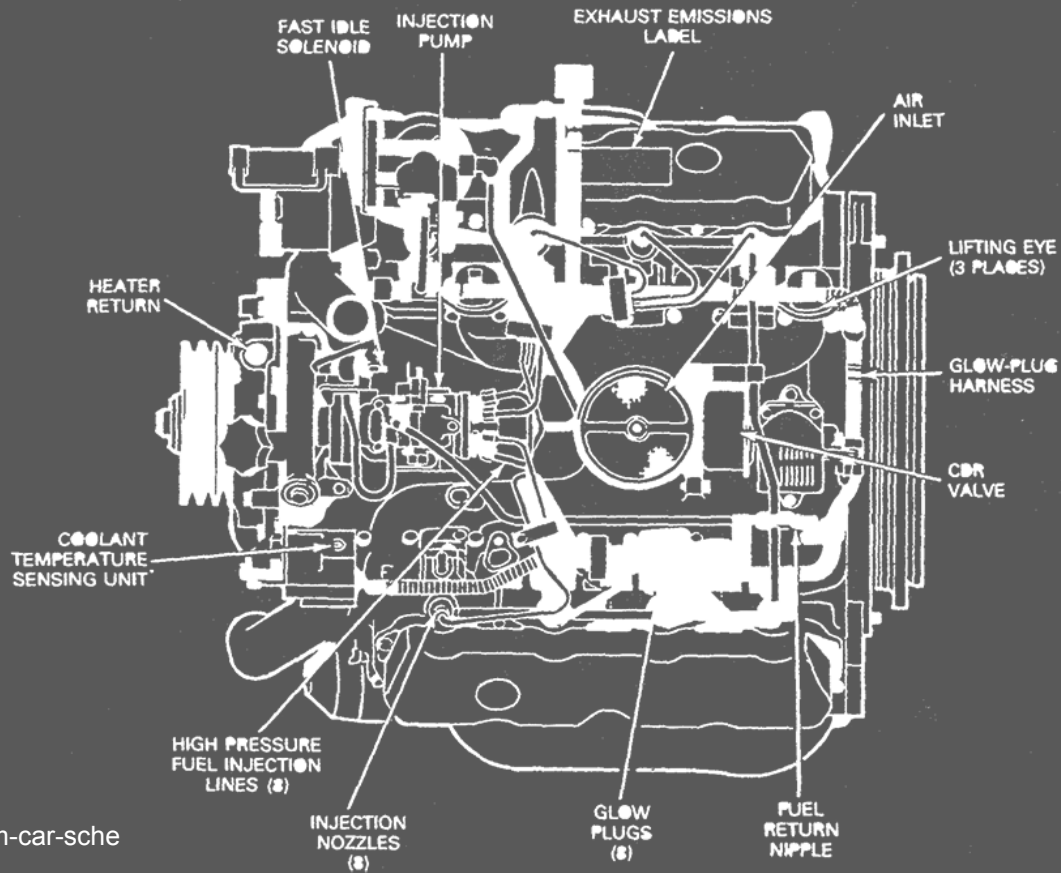


Image Source:
<https://www.cleanpng.com/png-wiring-diagram-car-schematic-house-3090057/download-png.html>

Interpreting output

If your engine is producing smoke, it might be overheating.

Foundational Knowledge

Your engine generates enormous heat. It needs coolant to prevent overheating.

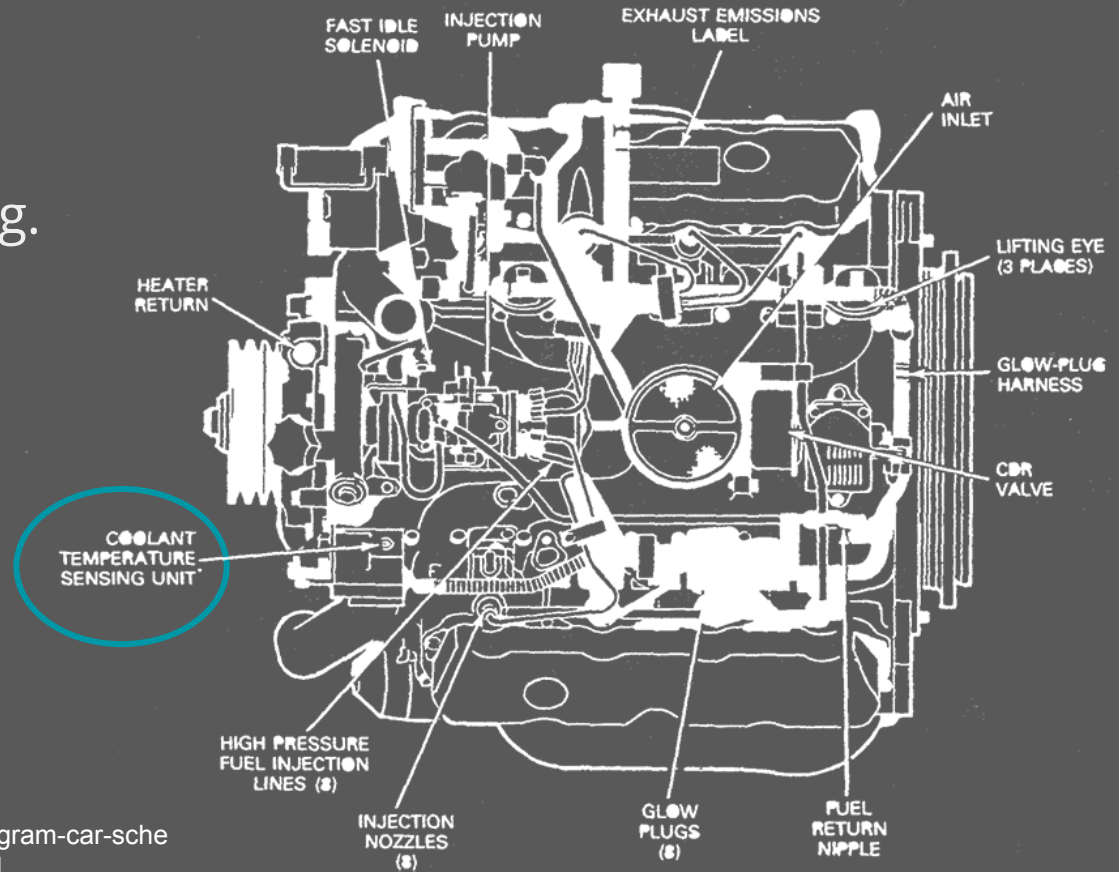


Image Source:

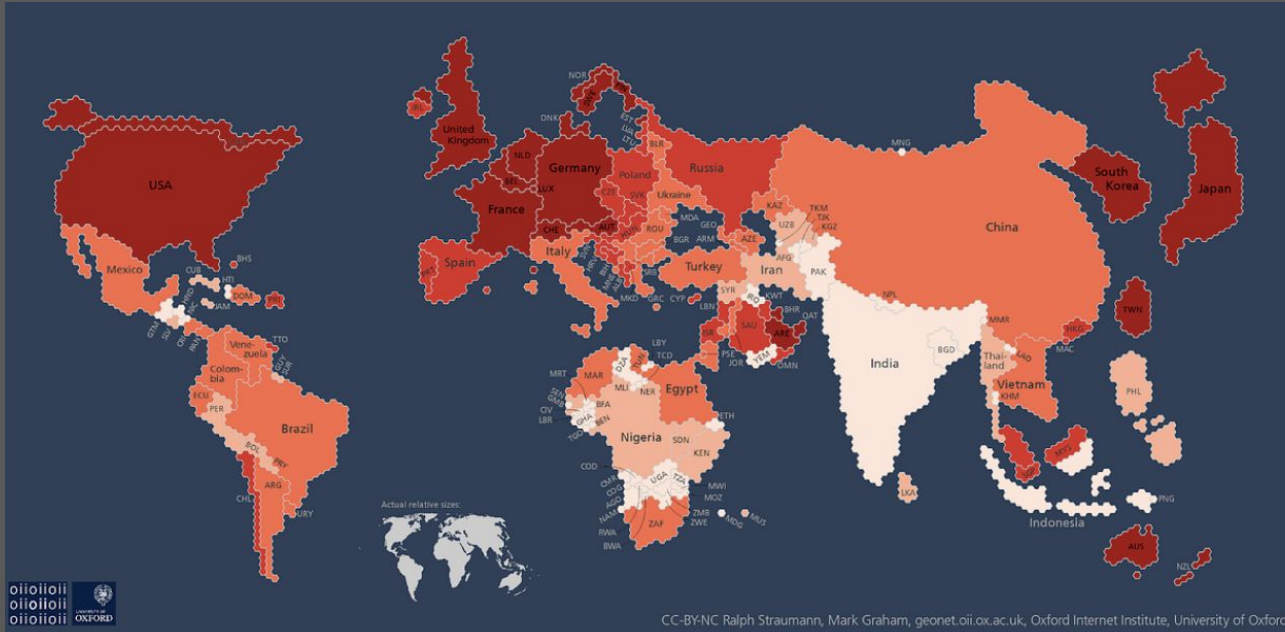
<https://www.cleanpng.com/png-wiring-diagram-car-schematic-house-3090057/download-png.html>



Write a list of 10 male surnames with first names.

Certainly! Here's a list of 10 male full names (first name + surname):

1. James Anderson
2. Michael Brown
3. David Clark
4. John Davis
5. Daniel Garcia
6. Matthew Johnson
7. Christopher Lee
8. Anthony Martinez
9. Joseph Miller
10. William Smith



The World Online

Percentage of people online

80–100% 60–80% 40–60% 20–40% 0–20%

Number of people online

One ● represents roughly 470,000 people online.

The countries are scaled proportionally to the number of Internet users in that country. Countries with fewer than 470,000 people online have been removed from the map. The shading indicates the percentage of the population that is online.

The visualization uses 2013 data from the World Bank's Worldwide Development Indicators project and from Natural Earth.

Image Source:
<https://geonet.oii.ox.ac.uk/blog/the-world-online/>

1.

English ↔ Hungarian

She is a doctor. He is a nurse. ×

Ő orvos. Ő ápolónő.

🎤 🔊 📄 🔊 🌐

2.

Hungarian ↔ English

Ő orvos. Ő ápolónő. ×

Did you mean: Ő orvos. ÉS ápolónő.

He is a doctor. She is a nurse.

🎤 🔊 📄 🔊 🌐



african people at work

No style

Generate



european people at work

No style

Generate

Original content generated
by Professor Safinah Ali at
New York University



outdoor recreation



Original content generated by a student in the Generative AI in K-12 Education Course, 6.s062, for the assignment "Generate a movie poster."

Goals of AI Literacy

We want people to be conscientious consumers of artificial intelligence.

We want people to be ethical designers of artificial intelligence.

We want people to be able to participate in democratic discussions around artificial intelligence.

The Future of AI in Education

Building (the same) things better or building better things?



What to teach youth in the age of AI?

- Critical thinking (e.g., Breideband et al., 2023)
- Projects, Passion, Peers, Play (Resnick, 2024)
- Self-regulated learning (SRL)
- Continuous learning to up-skill / re-skill
- Maintenance of agency

(Markauskaite et al. 2022)

What do teachers need to know in the age of AI?

- Teaching about how AI works (**AI Literacy**) is important

What do teachers need to know in the age of AI?

- Teaching about how AI works (**AI Literacy**) is important
- We need to change the way we teach.
 - Learning is social!
 - Students should be involved in making meaning

What do teachers need to know in the age of AI?

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- Teach students to learn with AI

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- Get comfortable in the teaching that knowledge is fallible

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- Teaching about how AI works (**AI Literacy**) is important
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- Teach students to learn with AI
- Get comfortable in the teaching that knowledge is fallible

How do we support teachers in this transformative work while maintaining their professional autonomy and elevating their expertise?

AI in Educational Outreach and Training

The Everyday AI (EdAI) Teacher PD Program



AI in Educational Outreach and Training

The Everyday AI (EdAI) Teacher PD Program

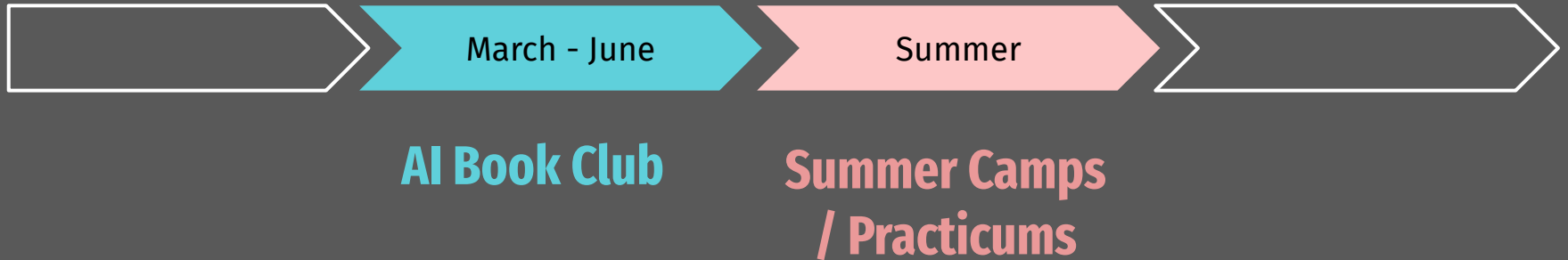


March - June

AI Book Club

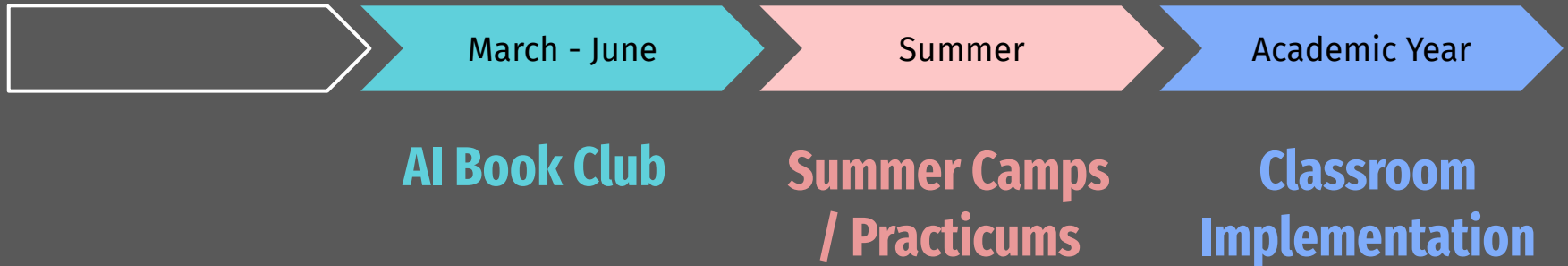
AI in Educational Outreach and Training

The Everyday AI (EdAI) Teacher PD Program



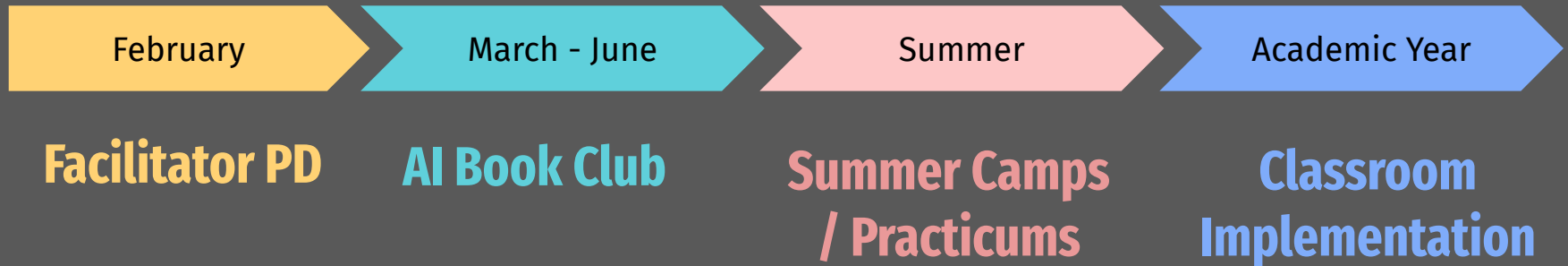
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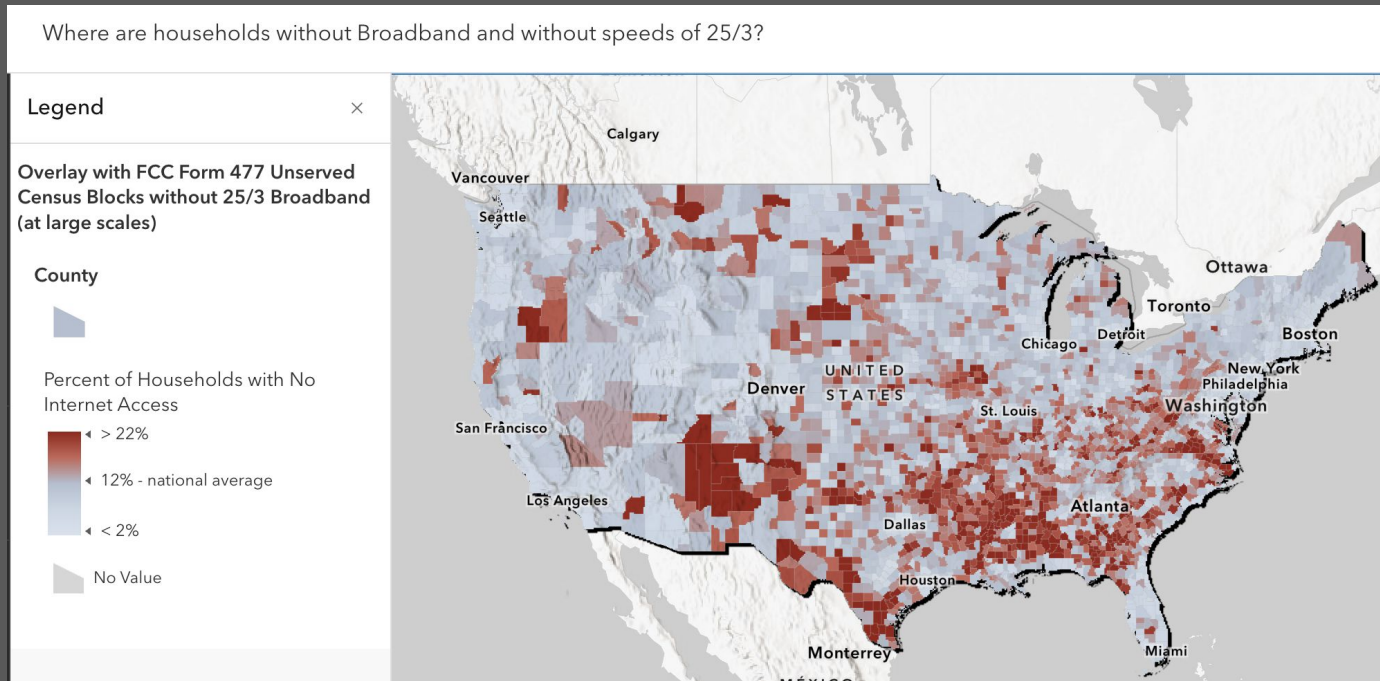


AI in Educational Outreach and Training

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Access to Technology & Digital Literacy



Source:
<https://www.maps.com/internet-accessibility-map-shows-digital-divide-underserved-broadband-areas/>

What makes education fundamentally human?

What makes education fundamentally human and how do we preserve this while embracing the emergence of new technology?

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- Local relevance & Place Based Education (PBE)
- Culturally Responsive & Sustaining Pedagogy (CRSP)
- Development of mindful socio-technical systems
- **Education is social**

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Thank you.

** Nearly all visuals for this presentation were made with assistance from Claude and Adobe Firefly, which are two generative AI tools.