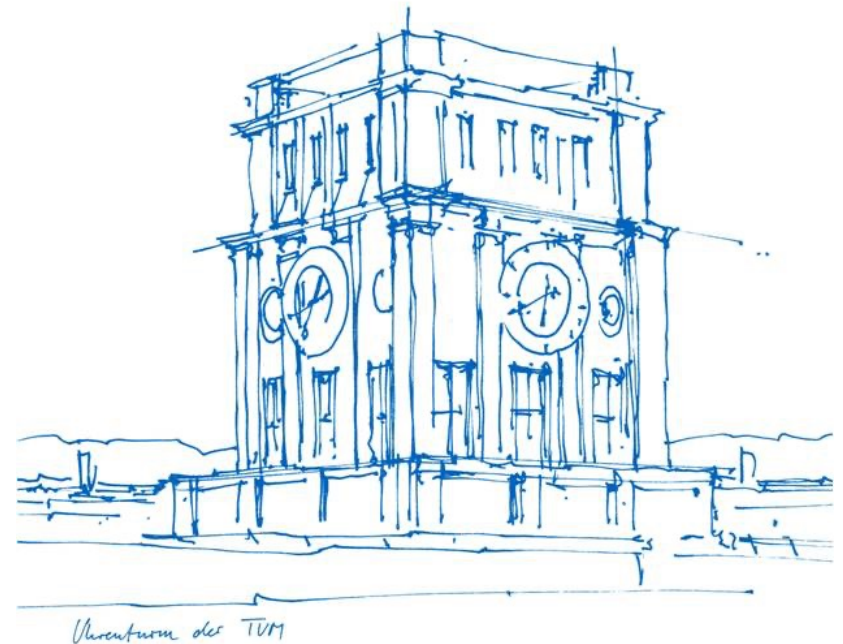


Learning analytics in the age of AI:

Will we see the promised learning revolution?

Prof. Dr. Oleksandra Poquet
Technical University of Munich
School of Social Sciences and Technology
Aachen, Germany, 12 September 2023



Outline:

Focus of the talk

Learning analytics

AI in Education: Why today is different

Why there may be no impact

Affordances of AI

LA for shared cognitive systems



Introduction

“On first sight, one might ask: **Haven't we had already a whole assortment of innovations**, new methods, new approaches, but most notably - new media and technologies? We had radio and we had film, we had educational television and we had computer-based instruction. **Promises about a rosy future reached sky high.** So, have they made the promised difference in the classroom? Come to think of it, they have not. **So, why would technology make a difference now?”**

Technology and Pedagogy: Why Don't We See the Promised Revolution?

Gavriel Salomon
University of Haifa

Classrooms of today, with the exception of a few daring pioneering cases, are not very different from those of yesteryear, despite the massive infusion of novel technologies into the schools and despite major changes all around us. The new information technology has not yet had much of an effect on formal education.

It is no secret that while schools need not be considered total failures, they are not doing as good a job as we'd like them to, either. Perkins (1992), to mention one scholar examining education, has quite correctly pointed out a number of bells alarming us about the shortfalls in regular educational achievements. What they attain, he writes, is:

[F]ragile knowledge, which means that students do not remember, understand or use actively much of what they have supposedly learned; and poor thinking, which means that students do not think very well with what they know. (p. 20)

A printing press



A calculator




A personal computer



A smartphone



The background of the text is a photograph of a chalkboard. It shows various mathematical scribbles and numbers in chalk, including '460', '5000', and some illegible words. A person's legs in dark pants are visible at the bottom of the frame.

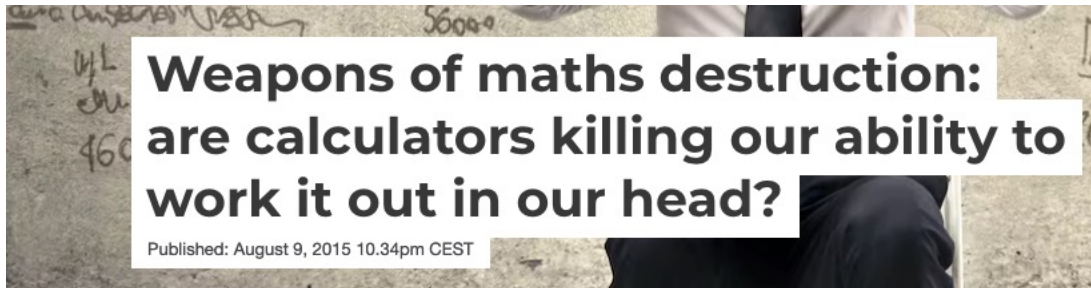
Weapons of maths destruction: are calculators killing our ability to work it out in our head?

Published: August 9, 2015 10.34pm CEST

Cambridge Festival of Ideas: Is social media killing off book reading?

By Alex Spencer - alex.spencer@iliffemedia.co.uk

Published: 19:05, 13 October 2019 | Updated: 19:07, 13 October 2019



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Randy Kulman Ph.D.
Screen Play

PLAY

"Is Too Much Minecraft Bad for My Child?"

How to make a passion for gaming—or anything else—into a passion for learning.

Posted October 14, 2022 | Reviewed by Devon Frye

OPINION POLICY

Is Massively Open Online Education A Threat Or A Blessing?

May 3, 2013 · 3:04 PM ET

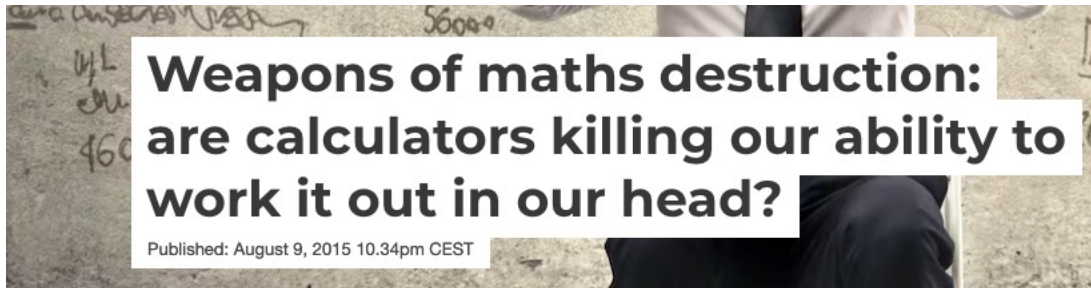
By [Alva Noë](#)

[Home](#) > [What's On](#) > [Article](#)

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THE Times Higher Education Home News Rankings Jobs Students Events Resources

News Home Latest Opinion **In-depth** Leadership Digital

Will learning analytics empower or entrap students and academics?

An academic parent, a student and two researchers consider if the metrics approach is really the game changer for improving student outcomes that many claim, or if it has a dark side

September 7, 2017

[Contributors](#)

Twitter Facebook LinkedIn Email



OPINION POLI
**Is Massi
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at's On > Article

a killing off

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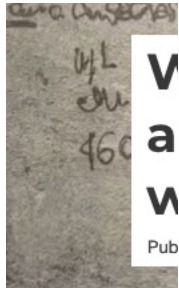
By Alva Nc

Mobile phones should be banned in schools, UN report says

26 July · [Comments](#)

Article

ng off



GETTY IMAGES

The UN says smartphones are distracting pupils from their lessons

passion for learning.

Posted October 14, 2022 | [Reviewed by Devon Frye](#)

FEATURE [TECH](#)

How ChatGPT and similar AI will disrupt education

Teachers are concerned about cheating and inaccurate information



Learning Analytics



Generative AI

What is on the intersection of LA and AI?



What is on the intersection of LA and AI?



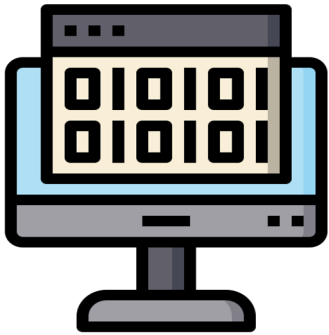
Will we see the promised change?





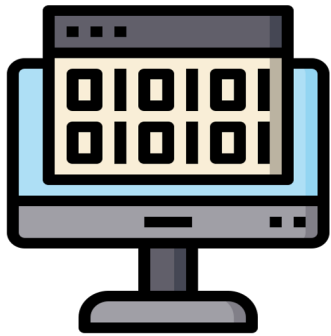
Learning Analytics

What is learning analytics?



system-made
data

What is learning analytics?

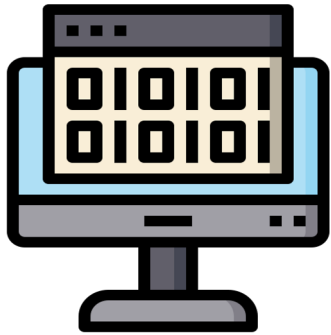


system-made
data



learning
process

What is learning analytics?



system-made
data



learning
process



actionable
feedback

Stepping Stones



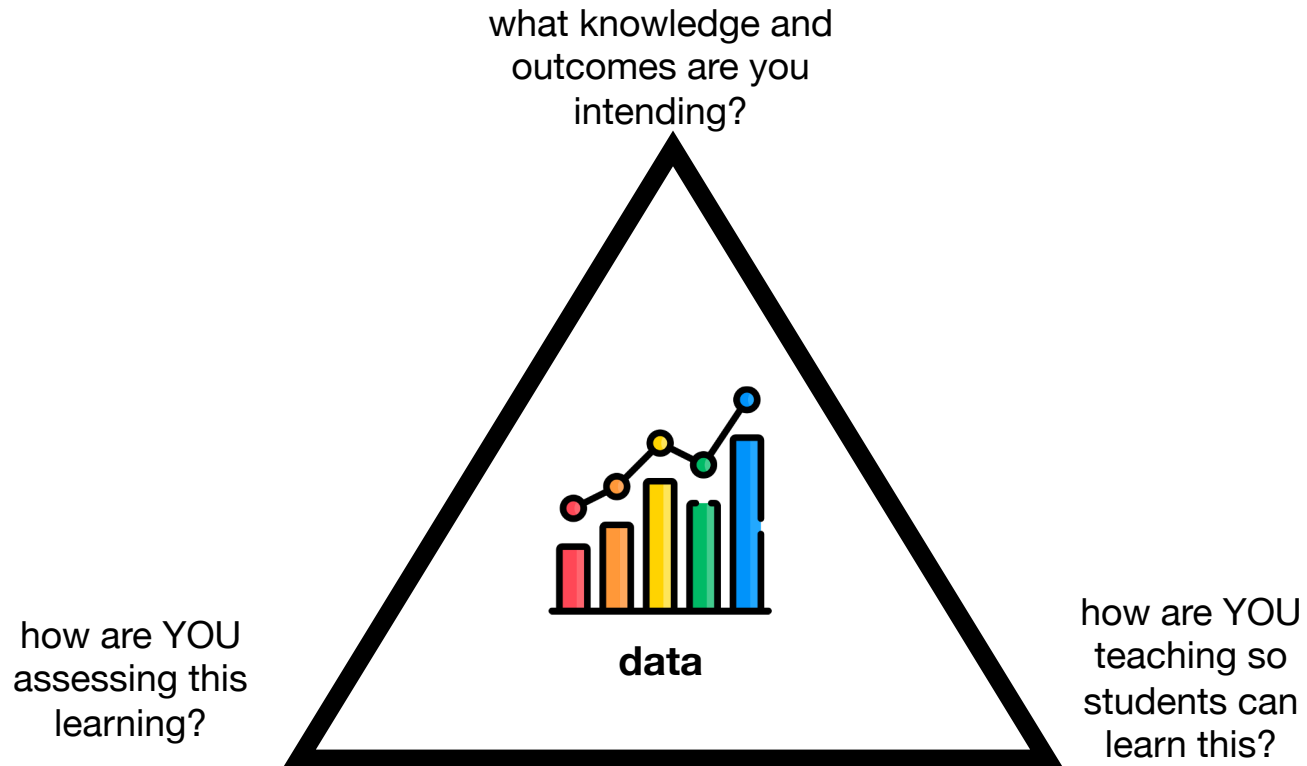
data



feedback



leadership



A learning ecosystem

A clear vision and applied project for analytics

End user scenarios must be considered first



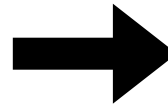
Stepping Stones



feedback

Data that helps capture

- engagement with reading
- performance on a 21st century skill
- effort or self-regulation
- reflective writing
- collaborative learning
- calibrating cognitive load in lectures
- engagement with video
- retention
- something else

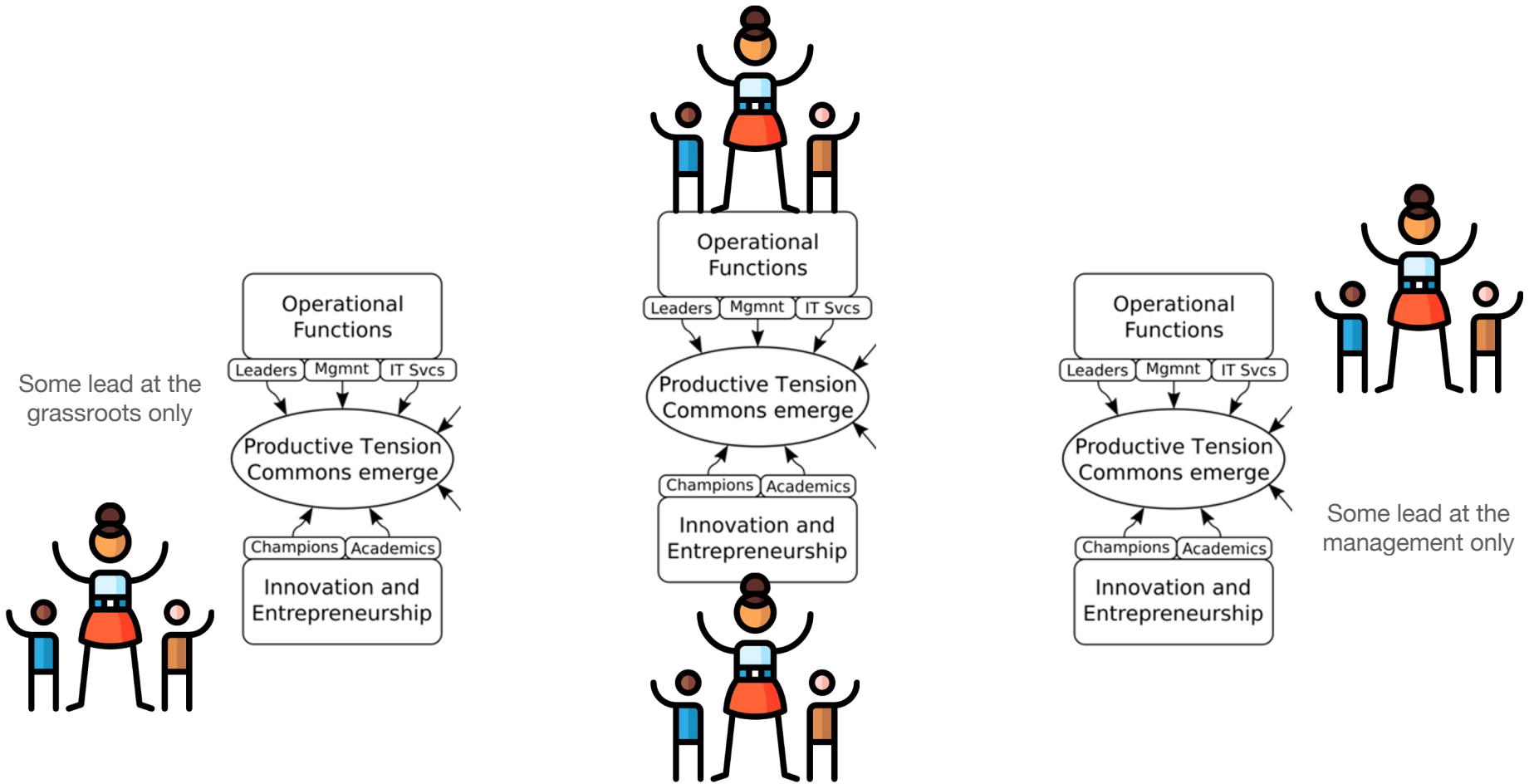


**CAN YOU TAKE ACTION ON SEEING
THESE DATA TO
IMPROVE ...**

Stepping Stones



leadership



Predictive learning analytics

Engagement analytics

Communication analytics

Multimodal learning analytics

Writing learning analytics

Curriculum analytics

Employability analytics

Highly Informative learning analytics / Learner Profiles

Learning analytics - Challenges

- Adoption
- Reproducibility
- Implications for equity

What is learning analytics *for*?

OPEN PEER COMMENTARY

A LAK of Direction

Misalignment Between the Goals of Learning Analytics and its Research Scholarship

Benjamin A. Motz, Yoav Bergner, Christopher A. Brooks, Anna Gladden, Geraldine Gray, Charles Lang, Warren Li, Fernando Marmolejo-Ramos, Joshua D. Quick

1-13

 PDF

Aligning the Goals of Learning Analytics with its Research Scholarship

An Open Peer Commentary Approach

Rebecca Ferguson, Hassan Khosravi, Vitomir Kovanović, Olga Viberg, Ashish Aggarwal, Matthieu Brinkhuis, Simon Buckingham Shum, Lujie Karen Chen, Hendrik Drachsler, Valerie A. Guerrero, Michael Hanses, Caitlin Hayward, Ben Hicks, Ioana Jivet, Kirsty Kitto, René Kizilcec, Jason M. Lodge, Catherine A. Manly, Rebecca L. Matz, Michael J. Meaney, Xavier Ochoa, Brendan A. Schuetze, Marco Spruit, Max van Haastrecht, Anouschka van Leeuwen, Lars van Rijn, Yi-Shan Tsai, Joshua Weidlich, Kimberly Williamson, Veronica X. Yan

14-50

 PDF



Multivocality: Learning analytics *should*

- Close the loop
- Advance learning theory
- Improve social justice
- Improve learning process
- Differentiate improvement of learning (process) vs outcomes
- Bring short-term meaningful improvement in the practice
- Bring long-term learning outcomes
- Bridge practitioner and researcher work

Ferguson, Rebecca, Hassan Khosravi, Vitomir Kovanović, Olga Viberg, Ashish Aggarwal, Matthieu Brinkhuis, Simon Buckingham Shum et al. "Aligning the Goals of Learning Analytics with its Research Scholarship: An Open Peer Commentary Approach." *Journal of Learning Analytics* 10, no. 2 (2023): 14-50.

Learning analytics (my view)

- LA has is uniquely positioned as a ‘middleground’ space (Cohendet et al., 2014; Suthers & Verbert, 2013) between learners, teachers, and institutional stakeholders, between data, learning process, and pedagogical practice, and needs to be practicable (Viberg & Gronlund, 2023).
- I understand learning analytics as a field with potential scientific impact = its own theory developed through a scientific process and requiring interventions when the insights are mature.

Learning analytics (my view)

- **Indicators** (to advance [digital] learning theory)
- **Analytics** (to communicate about learning process)
- **Sensemaking** practices (to support acting on feedback)



AI in Education

Multiple notions of AI



Methodology
for
researchers



Legend
for
industry



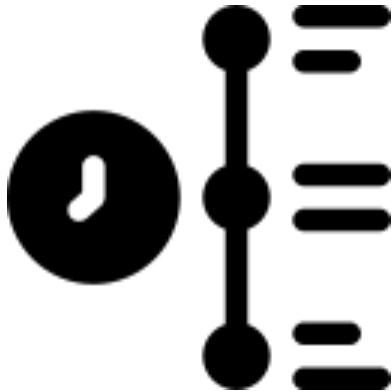
Rhetoric
for
Policy groups

Eynon, R., & Young, E. (2021). Methodology, legend, and rhetoric: The constructions of AI by academia, industry, and policy groups for lifelong learning. *Science, Technology, & Human Values*, 46(1), 166-191.

What is AIED?

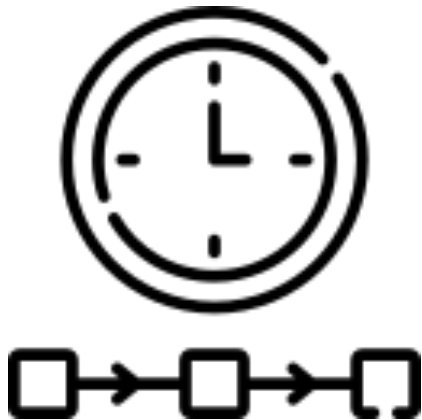
“Applied field, with the goal of creating software that helps people learn better.”

Early approaches



- Pressey 1926
 - Skinner 1954
 - Suppes 1966
- PLATO & TICCIT systems

The first era of AIED research 1940-1982



Focus areas

- Support problem-solving in STEM domains
- Diagnose problem solving strategies
- Devise pedagogical approaches to help students overcome issues
- “Student modelling”

The second era of AIED research 1982-1995

ITS architecture

- Knowledge representation (structured domains, causal graphs)
- Student modelling
- Pedagogical component (topics to adapt)
- Communication component (terminology)



Cognitive tutoring as a strong emergent tradition

Pedagogical strategies (early work by Goodyear, Vassileva, Brusilovsky, du Boulay, Wasson)

The authoring environments and frameworks

The second era of AIED research 1982-1995

Also

Collaborative and social learning approaches
e.g. interacting with a computer to teach it

Reflective activity – self-explanations

Open learner models (Cumming and Self, 1991)



Large Language Models (in education)

118 papers

53 use cases for LLMs in
automating education tasks

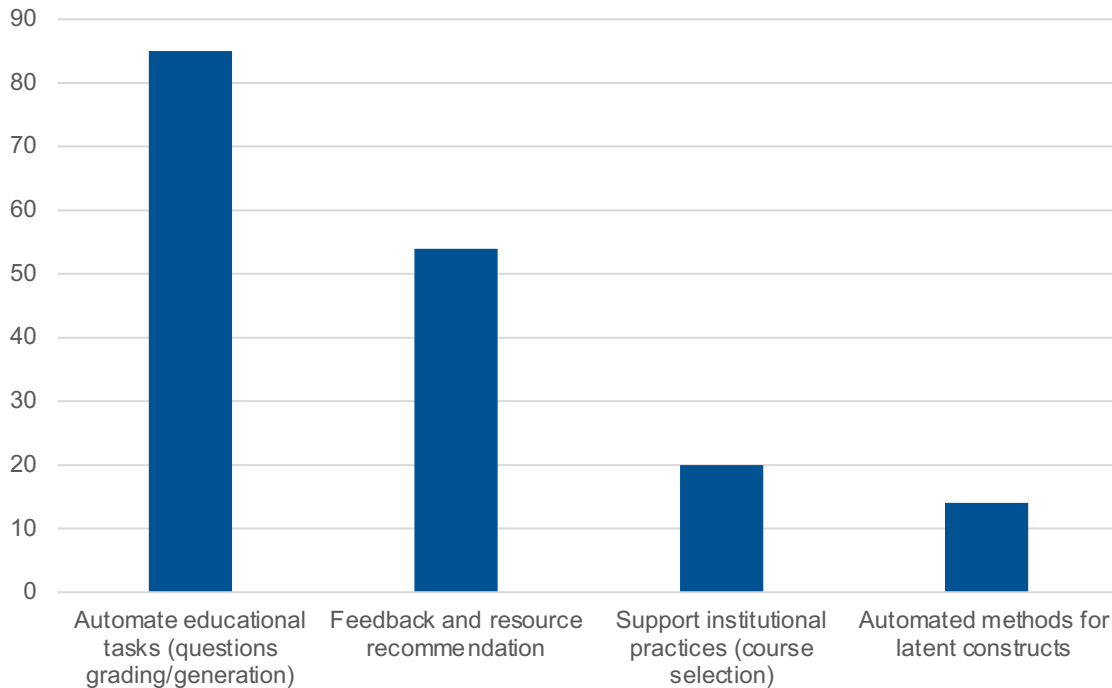
Categories of use cases

- profiling/detection
- Grading teaching support
- prediction
- knowledge representation
- feedback
- content generation
- recommendation.



Yan, L., Sha, L., Zhao, L., Li, Y., Martinez-Maldonado, R., Chen, G., ... & Gašević, D. (2023). Practical and ethical challenges of large language models in education: A systematic scoping review. *British Journal of Educational Technology*.

Large Language Models (in education)



Novel
applications?

Yan, L., Sha, L., Zhao, L., Li, Y., Martinez-Maldonado, R., Chen, G., ... & Gašević, D. (2023). Practical and ethical challenges of large language models in education: A systematic scoping review. *British Journal of Educational Technology*.



What is potentially transformative about LLMs?

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1. LLM-specific knowledge
 - students need to understand the basics of LLMs and AI writing tools strengths & limitations
2. Functional knowledge
 - students need to use AI writing tools across tasks
3. Interacting with AI
 - students need to prompt the AI

What is potentially transformative about LLMs?

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2. Functional knowledge
 - students need to use AI writing tools across tasks
3. Interacting with AI
 - students need to prompt the AI
4. Implications for learning process and learning outcomes
 - Do students become better writers with or without; how do students learn using various prompting and editing techniques?
5. Implications for learning theory
 - what does this new 'language' and 'tool' mean for learning theories (Vygotsky, Engeström)

What is potentially transformative about LLMs?

Not just writing

How does this impact literacy?



What can be the promise of LA
and AI?

What is *worth* doing?



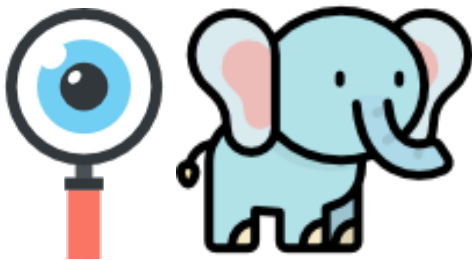
“What keeps education
from undergoing the kind of pedagogical change
that the new, brave world of novel technology
has promised?”
(Salomon, 2002, p.71)



1. Trivializing a Good Thing



2. The Technocentric Focus



3. Misguided Research



1. Trivializing a good thing

- “Technology is allowed to do precisely that which fits into the prevailing educational philosophy of cultural transmission and training for the world of yesterday”



1. Trivializing a good thing

- “Technology is allowed to do precisely that which fits into the prevailing educational philosophy of cultural transmission and training for the world of yesterday”
- “Most powerful and innovative technology is taken and domesticated... - trivialized, such that it does more or less what its predecessors have done, only it does it a bit faster and a bit nicer”



2. The Technocentric Focus



2. The Technocentric Focus :

- Technology will bring change on its own



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- Not knowledge but technology becomes centrepiece



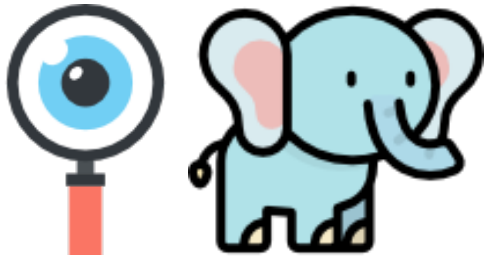
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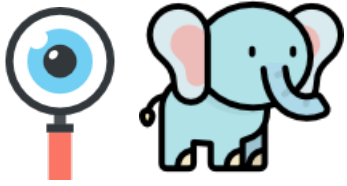


2. The Technocentric Focus :

- Technology will bring change on its own
- Not knowledge but technology becomes centrepiece
- Access to information is equalled to knowledge
- Ignored that knowledge building requires:
 - Co-presence
 - Tutelage (e.g. by extending the Zone of Proximal Development)
 - Community of learners

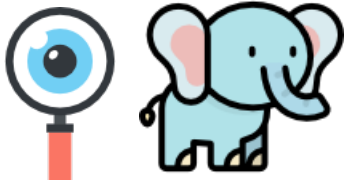


3. Misguided Research



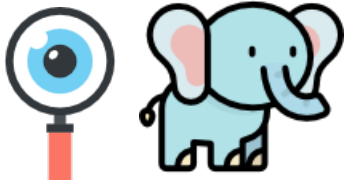
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- “Does the use of medium X produce better learning results than medium Y (usually a teacher)?“
 - “The horse-race approach – who teaches faster, who leads to more traditional achievements – disregards aptitudes, tasks, contents, and contexts”



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- What do we end up measuring? Traditional achievements
 - New technology should NOT be viewed as the means to attain the same old goals of traditional education
 - “Nothing wrong with 3Rs but introducing new technology is not to do the same things better but to reach profound improvements: variety of outcome variables need to be considered”



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 - Nothing wrong with 3Rs but introducing new technology is not to do the same things better but to reach profound improvements: variety of outcome variables need to be considered
- Misguided research will keep reinforcing the technological paradox and the technocentric approach.

Where to?

- The tool merely offers affordances and opportunities – but for what?
- What do we want education to become?

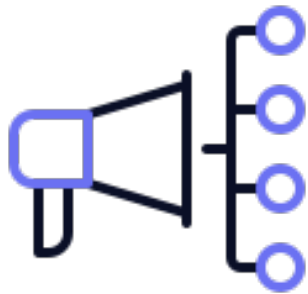


Salomon (2002)

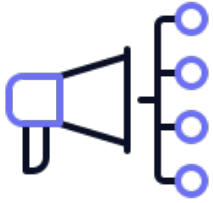


Emergent insights into LLMs

Emergent research into LLMs

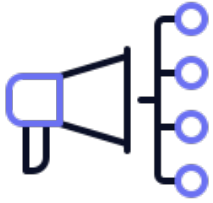


Automating feedback



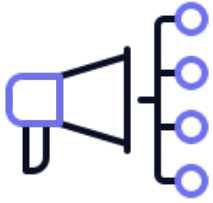
Automating feedback

- Students who had access to AI-generated feedback in programming tasks performed better but
 - Less likely to solve correctly immediately when the feedback was removed though corrected reasonable fast
 - (Pankiewicz & Baker, 2023)



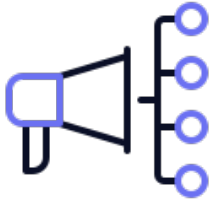
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 - 70% of Chat-GPT produced hints passed manual quality checks
 - (Pardos & Bhandari, 2023)



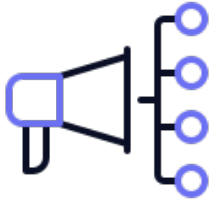
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- Human hints in algebra tasks produced better learner outcomes
 - 70% of Chat-GPT produced hints passed manual quality checks
 - (Pardos & Bhandari, 2023)
- ChatGPT evaluated correctness of the student answers in math as well as instructors and generated equal quality feedback
 - (Nguyen et al., 2023)
 - Responded well to conceptual questions but struggled with decimanl place values and number line problems
 - Accurately assessed 75% of student answers



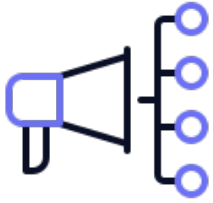
Automating feedback - thoughts

Very much within the tradition of ITS and teacher-medium comparison.



Automating feedback - thoughts

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Maybe should be called correctness rather than feedback?

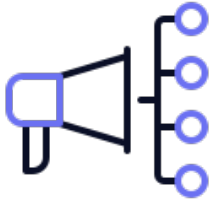


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Needed but need to account for content, context, process, task, participant characteristics.



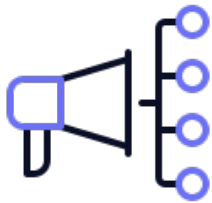
Automating feedback - thoughts

Very much within the tradition of ITS and teacher-medium comparison.

Maybe should be called correctness rather than feedback?

Needed but need to account for content, context, process, task, participant characteristics.

Needed to be also embedded in more open ended systems that can co-evolve collective knowledge and learner skills



Automating feedback - Example

Using AI-based scaffolds to support various processes in peer-based learner-sourcing system

Emergent research into LLMs



Generating courses



Generating courses

- ChatGPT creates tasks that are as correct as those created by teachers from the textbook.
 - (Küchemann et al. 2023)



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Generating courses

- ChatGPT creates tasks that are as correct as those created by teachers from the textbook.
 - (Kucheman et al. 2023)
- Students using the textbook achieved a higher clarity and more frequently embedded their questions in a meaningful context.
 - (Kucheman et al. 2023)
- Content created with LLMs is clearer but less accurate.
 - Leiker, Finnegan, Gyllen, Cukurova, 2023



Generating courses - thoughts

- What are the implications for teacher agency?
- What are the negative implications of such off-loading?
- Institutional transformation and learning about teaching is one way to create impact



Generating tasks - Example

Using AI-generated course design
for institutional transformation

Emergent research into LLMs



Shared cognitive systems

Examples of conceptualisations by
Holstein, Alevan, Rummel, 2020; Siemens et al., 2022



Shared cognitive systems

- Towards agentic engagement
 - Buddemeyer, Hatley, Stewart, Solyst, Ogan, Walker, 2021

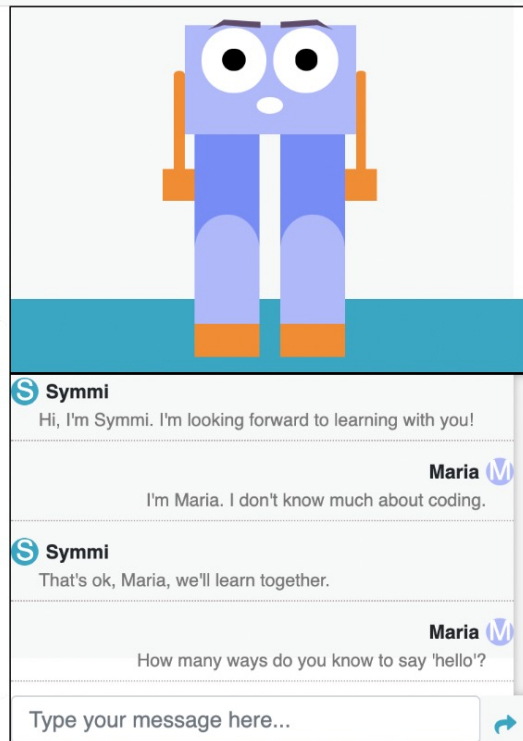


Figure 1: A screen shot showing the robot character and with its chat box below



Shared cognitive systems

- Towards agentic engagement
 - Buddemeyer, Hatley, Stewart, Solyst, Ogan, Walker, 2021
- Human-AI co-orchestration
 - Lawrence et al. 2023; Holstein & Olsen, 2023



Shared cognitive systems

- Towards agentic engagement
 - Buddemeyer, Hatley, Stewart, Solyst, Ogan, Walker, 2021
- Human-AI co-orchestration
 - Lawrence et al. 2023. Holstein & Olsen, 2023)
- Shared decision-making
 - Kawakami et al. 2023. Training Towards Critical Use: Learning to Situate AI Predictions Relative to Human Knowledge.
 - The notion of critical use— that is, humans' ability to situate AI predictions against potentially complementary knowledge uniquely available to them (but not the AI model).
 - Participants disagree with the AI prediction more after repeated practice.



Shared cognitive systems

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 - Buddemeyer, Hatley, Stewart, Solyst, Ogan, Walker, 2021
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 - Lawrence et al. 2023. Holstein & Olsen, 2023)
- Shared decision-making
 - Kawakami et al. 2023. Training Towards Critical Use: Learning to Situate AI Predictions Relative to Human Knowledge.
- Analytics of shared processes
 - Zeng, Sha, Li, Yang, Gasevic, Chen. 2023. Towards automatic boundary detection for human-AI collaborative hybrid essay in education.




Shared cognitive systems

- Towards agentic engagement
 - Buddemeyer, Hatley, Stewart, Solyst, Ogan, Walker, 2021

- Human-AI
 - Lawre tool: A

- Shared d

- Analytics
 - Zeng huma



51%

Our ensemble of detectors predict **different results** for this text. Please enter more text for more precise predictions.

There is a **51%** probability this text was written by AI

Sentences that are likely written by AI are **highlighted**.

1. The author concludes the story with this paragraph because it shows hope for the character Saeng.
2. This paragraph represents hope because it includes "snow melting and the geese return" as a metaphor for the hard times being even as winter, and the geese returning as a metaphor for remorse.
3. The last paragraph also states "and this hibiscus is budding" which can be seen as a metaphor for Saeng who is represented by the plant in a this can be seen throughout the story as the different plants bring memories to the character, and one relates to them in a that they come from the same home.
4. Saeng's connection to the hibiscus plant represents her connection to her past and her home country.
5. By vowing to retake her driver's test in the spring, Saeng is showing her determination to move forward and overcome her obstacles.
6. The hibiscus plant also represents growth and new beginnings, which is what Saeng is striving for.
7. Overall, the author concludes the story with this paragraph to leave the reader with a sense of hope and optimism for Saeng's future.

0/7 sentences are likely AI generated.

AI co-orchestration

detection for



Shared cognitive systems - thoughts

- Questions of offloading
 - how much you offload and what are the effects?



Shared cognitive systems - thoughts

- Questions of offloading
 - how much you offload and what are the effects
- Questions of mirroring – how much to trust
 - analytics to support evaluative judgement and probabilistic thinking



Shared cognitive systems - thoughts

- Questions of offloading
 - how much you offload and is this good for you
- Questions of mirroring – how much to trust
 - analytics to support evaluative judgement and probabilistic thinking
- Questions about scaffolding
 - how to support agents engagement in less regulated learners



Shared cognitive systems - example

Partners in Cognition: Extending Human Intelligence with Intelligent Technologies

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“Can machines make people more intelligent?
More specifically, with the increasing use of
intelligent computer programs, tools, and
related technologies in education, it may be an
opportune time to ask whether they have any
effect on students' intellectual performance and
ability.”

Salomon, Perkins, Globerson (1991)

A brief and modified version of this paper was presented as an invited address by Gavriel Salomon to the Annual Meeting of the American Educational Research Association (April, 1988) and was published in part in the *Proceedings of the 24th International Congress of Psychology* (Vol. 4).

Partners in cognition

- Salomon, Perkins, Globerson (1991) outline a conceptual framework:
 - Effects with technology
 - *Effects obtained during the partnership with technology*
 - Effects of technology
 - *Transferrable cognitive residue that this partnership leaves behind*

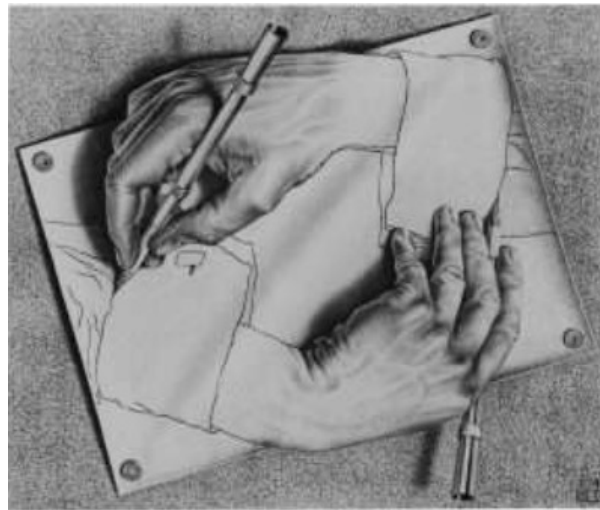


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Partners in cognition

- Salomon, Perkins, Globerson (1991)
 - **“Cognitive effects with computer depend on mindful engagement of learners in the tasks afforded by these tools AND that there is a possibility of qualitatively upgrading the performance of the joint system”**
 - Is ability a measure of one’s own or a measure of a system?
 - *The question of transfer: Can a cognitive effect of technology be engineered by designing the technology, the activity, and the setting to foster mindful abstraction of thinking skills and strategies?*

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 - Is ability an measure of one's own or a measure of a system?
 - ***The question of transfer: “Can a cognitive effect of technology be engineered by designing the technology, the activity, and the setting to foster mindful abstraction of thinking skills and strategies?”***

- 1. Learning analytics for shared cognitive systems**
- 2. Adaptable learning analytics, i.e. can *be* adapted**

Learning analytics (my view)

- **Indicators** (to advance [digital] learning theory)
- **Analytics** (to communicate about learning process)
- **Sensemaking** practices (to support acting on feedback)

Analytics and practices for shared socio-technical cognitive systems

- **Indicators** of what learners do and what AI does as mapped to learning processes/outcomes (writing, self-regulation, communication)
- **Analytics** to communicate about these processes to learners and inform about trade-offs of offloading
- **Sensemaking** practices – adaptable learning analytics

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