



Bochum University
of Applied Sciences
TECHNOLOGY BUSINESS HEALTH



The Never- Skilled Generation

Deskilling, Cognitive Offloading and the Long-Term Risks of AI- Supported Learning

Jonas Schug / Bochum University of Applied Science



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The Never- Skilled Generation

Deskilling, Cognitive Offloading and the Long-Term Risks of AI- Supported Learning

(and a Solution?)

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The Aim of Higher Education?

The Aim of Higher Education?

Universities teach two things:

Knowledge

what students need to know

Competence

what students need to do with it

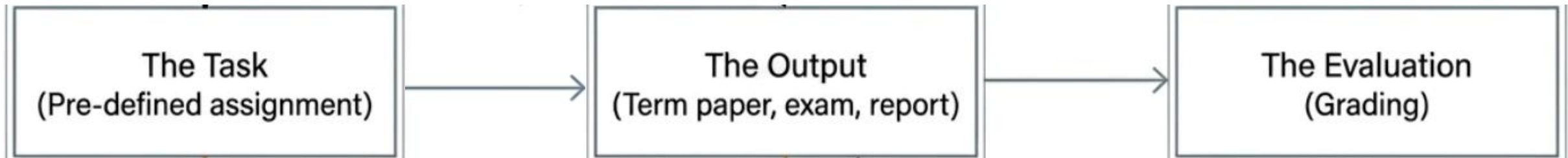
Higher Education Chain of Inference

The Task
(Pre-defined assignment)

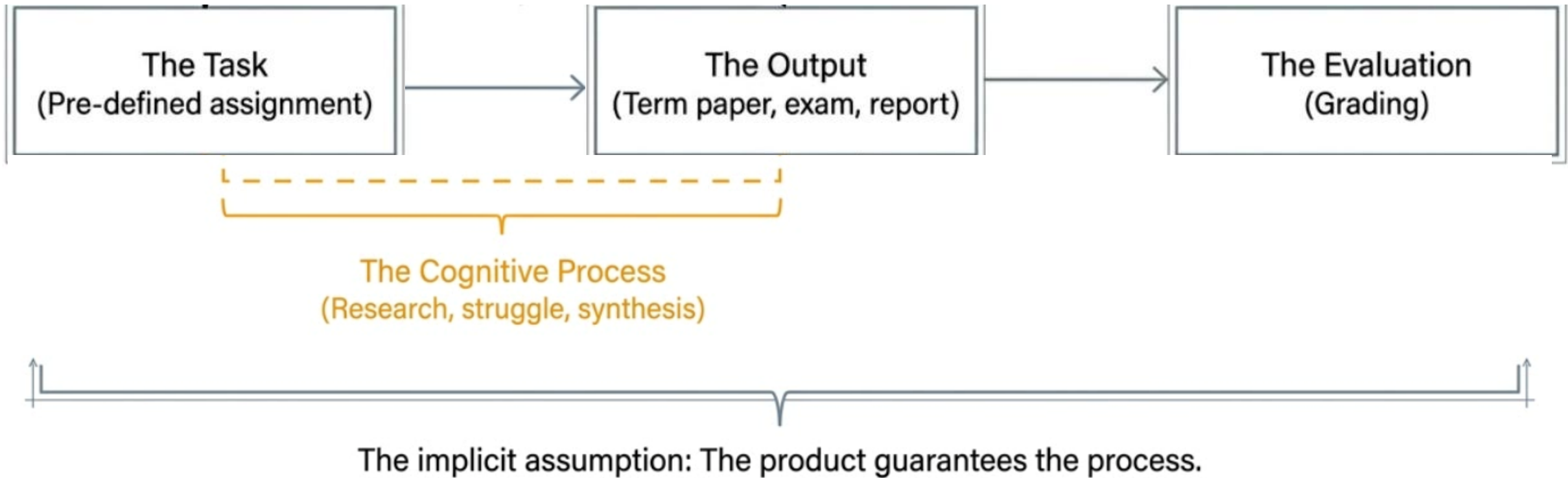
Higher Education Chain of Inference



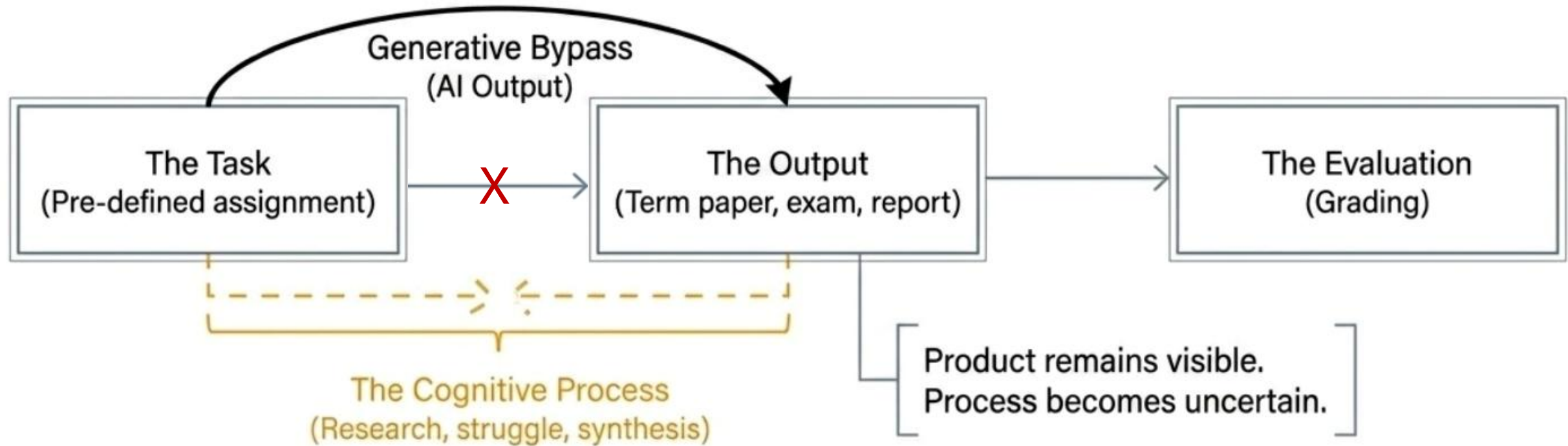
Higher Education Chain of Inference



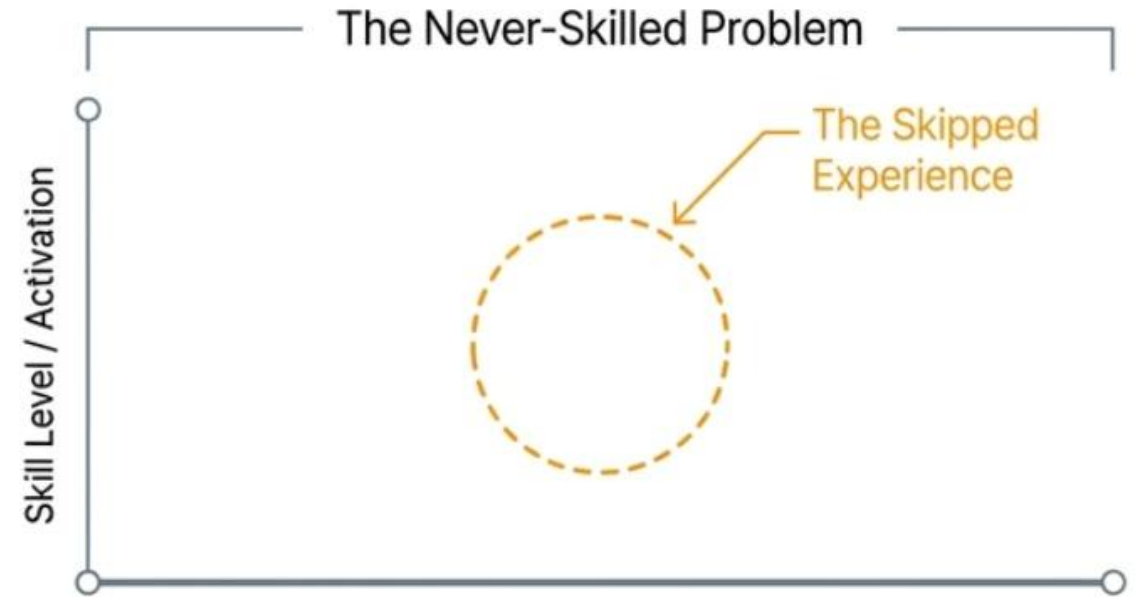
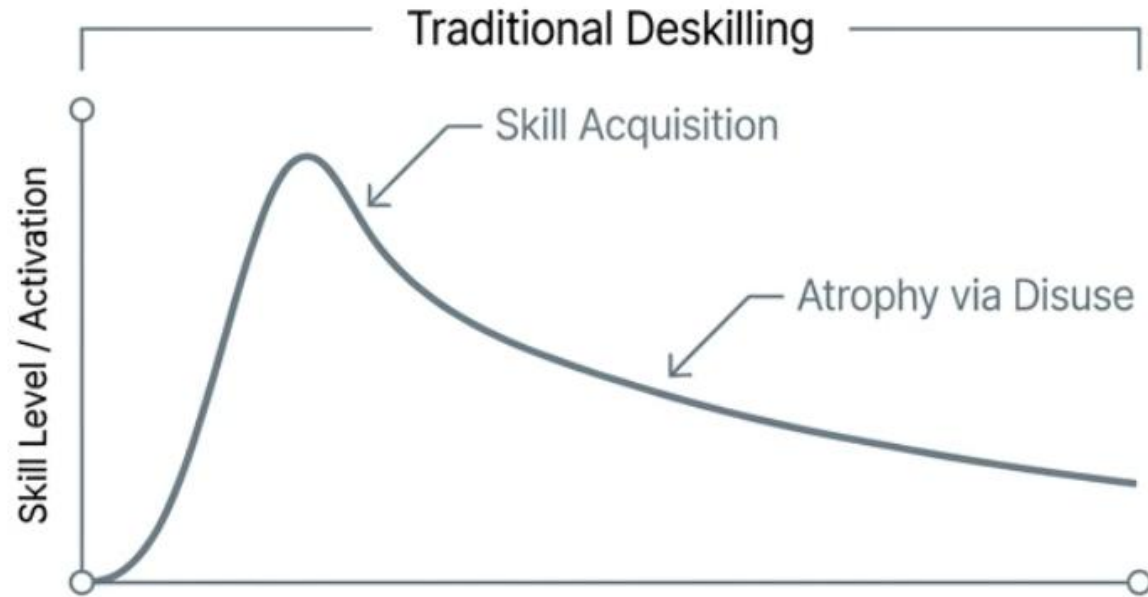
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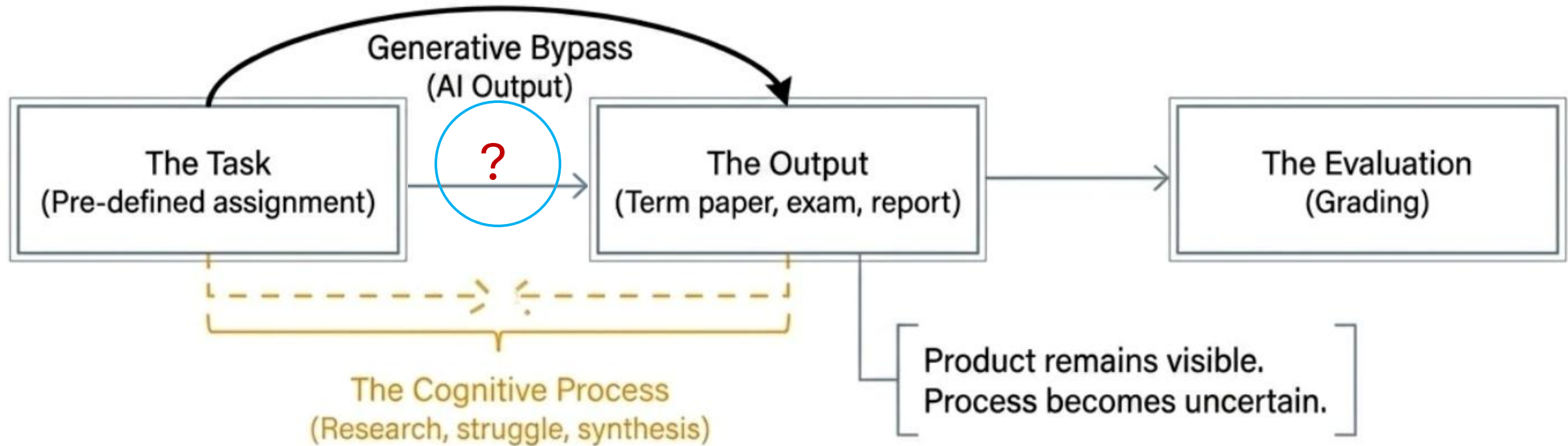
Higher Education Chain of Inference



The Never-Skilled-Problem:



Higher Education Chain of Inference



The Sequencing Timeline Metaphor

Learning process

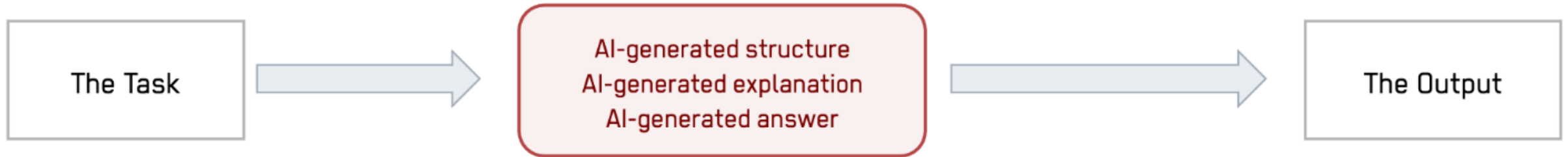
Task

Research → First struggle → Revision → Synthesis

Output

Sources: Kapur (2008); Loibl, Roll, & Rummel (2017); Koedinger & Aleven (2007); Bastani et al. (2025).

No struggle (with AI):



Potentially shortened: search time • persistence • retrieval • error correction • self-explanation

Bastani et al. (2025)

GPT-4 improved practice performance.
Without guardrails, later independent performance declined.
A scaffolded tutor mitigated the effect.

Rismanchian et al. (2026)

"Faster completion, less learning."
AI-susceptible tasks were completed faster.
Proctored retention performance declined.

Barcaui (2025)

ChatGPT-supported learning
led to lower delayed retention
after 45 days.

The Sequencing Timeline Metaphor

Learning process

Task

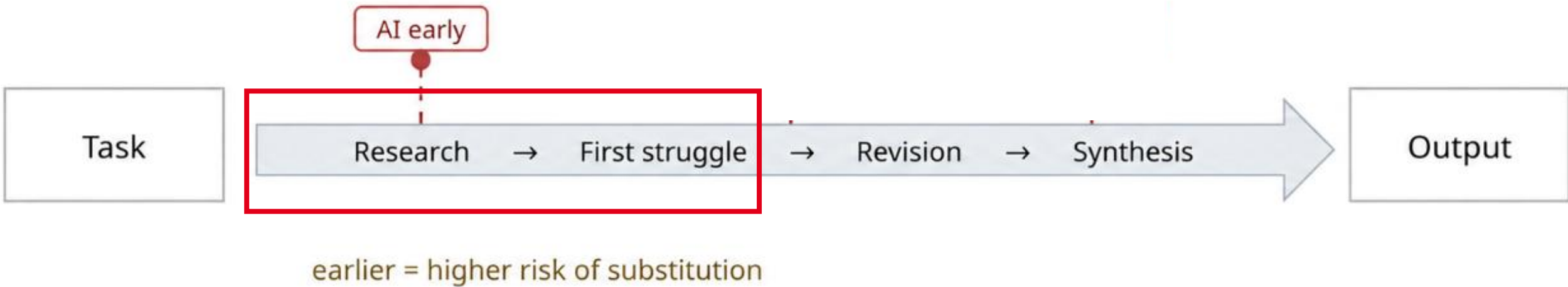
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The Sequencing Timeline Metaphor

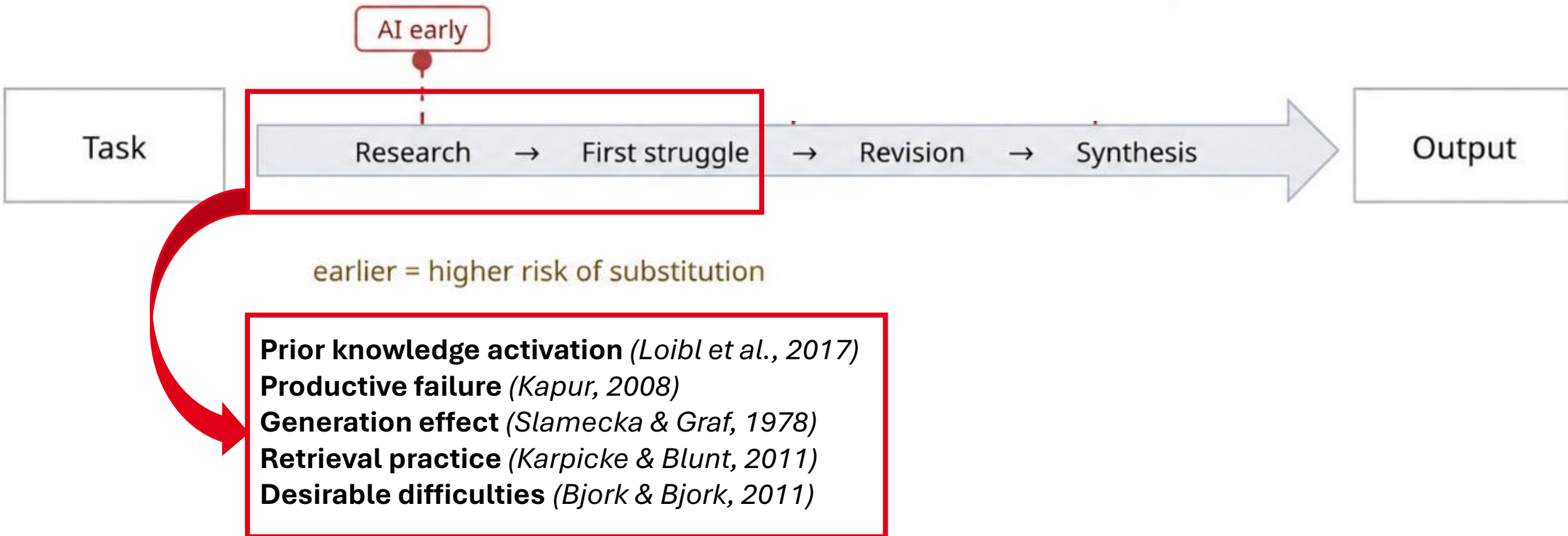
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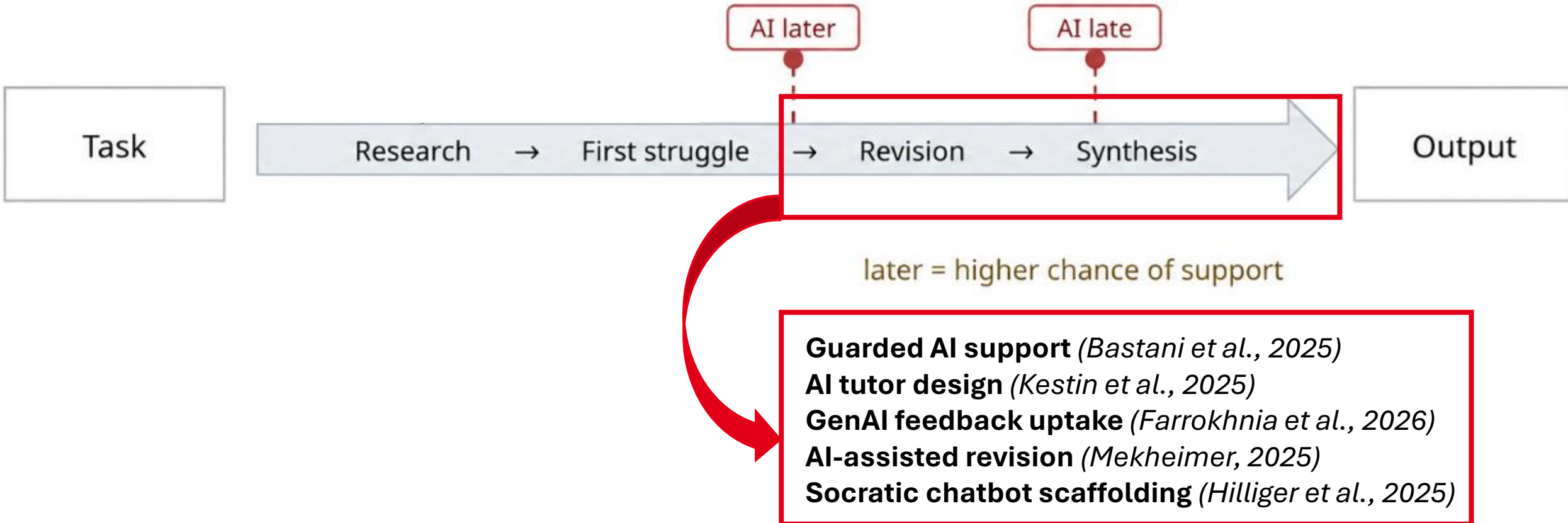
Learning process



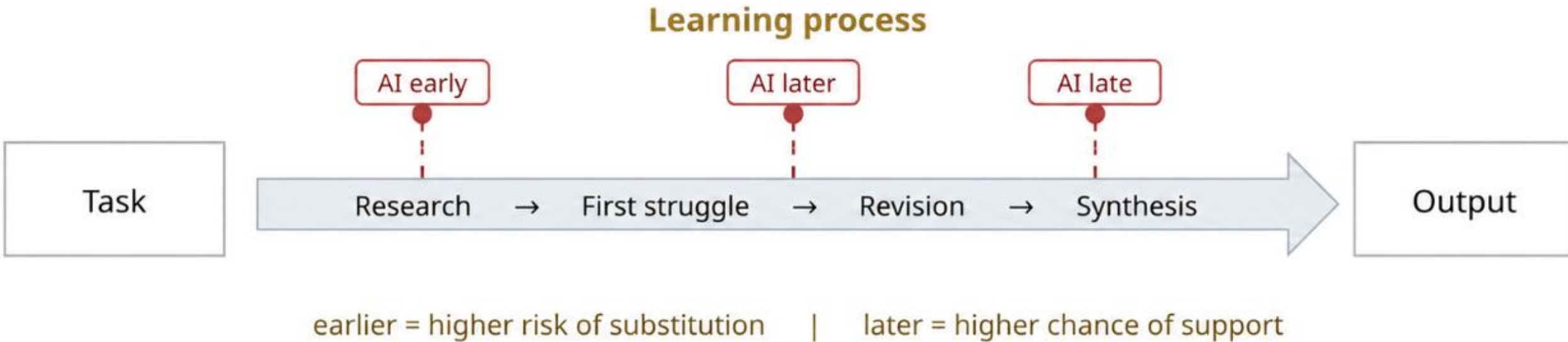
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The Sequencing Timeline Metaphor

Learning process



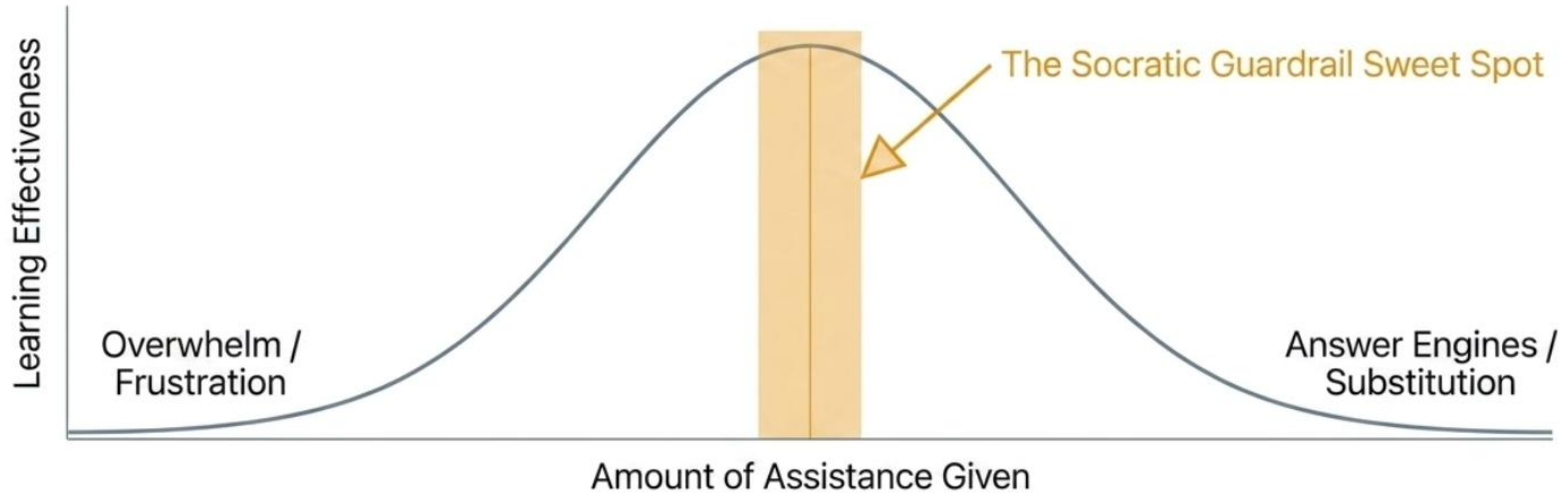
The Sequencing Timeline Metaphor



AI is not necessarily harmful to learning.

What matters is when it enters the process.

The Assistance Dilemma Curve



Koedinger & Alevan (2007); Wood, Bruner, & Ross (1976)

Our (proposed) solution....

Knowledge

Competence

Our (proposed) solution....

Knowledge

WOTUM

AI teaching & learning agent

Competence

Our (proposed) solution....

Knowledge

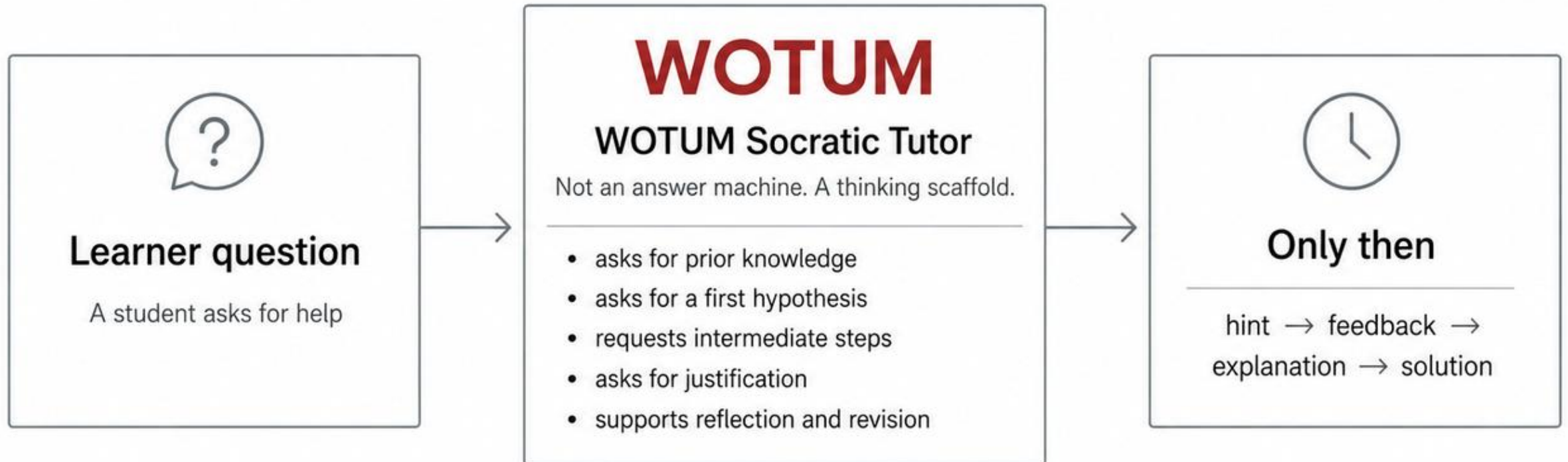
WOTUM

AI teaching & learning agent

- configured with Socratic guidelines
- no direct answer first
- knowledge on demand

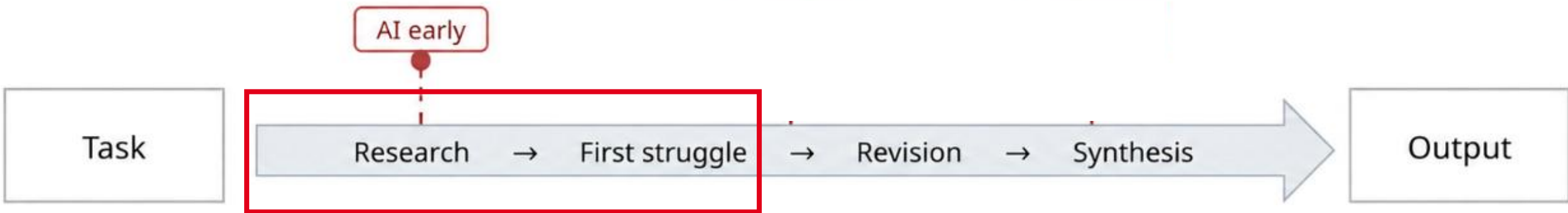
Competence

AI Learning Agent with Guidelines



The Sequencing Timeline Metaphor

Learning process



earlier = higher risk of substitution



Socratic Chatbot refuses to answer!

AI Learning Agent with Guidelines

WOTUM
Write Once – Transfer – Use Multiple

Configured by teachers

- learning goals and criteria
- materials and references
- feedback and control logic
- local / GDPR-compliant deployment

Socratic guidelines

- ask for own hypothesis first
- request intermediate reasoning
- give hints before solutions
- make assumptions explicit

Learning support

- adaptive multimodal materials
- criterion-referenced feedback
- transparent references
- support within guardrails

- Developed as part of a third-party funded project
- Currently being tested in two university courses.
- Planned rollout for broader teaching use: next year.



Our (proposed) solution....

Knowledge

WOTUM

AI teaching & learning agent

Competence

Our (proposed) solution....

Knowledge

WOTUM

AI teaching & learning agent

Competence

Problem-Based Learning

Our (proposed) solution....

Knowledge

WOTUM

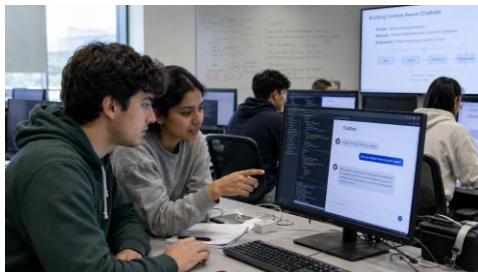
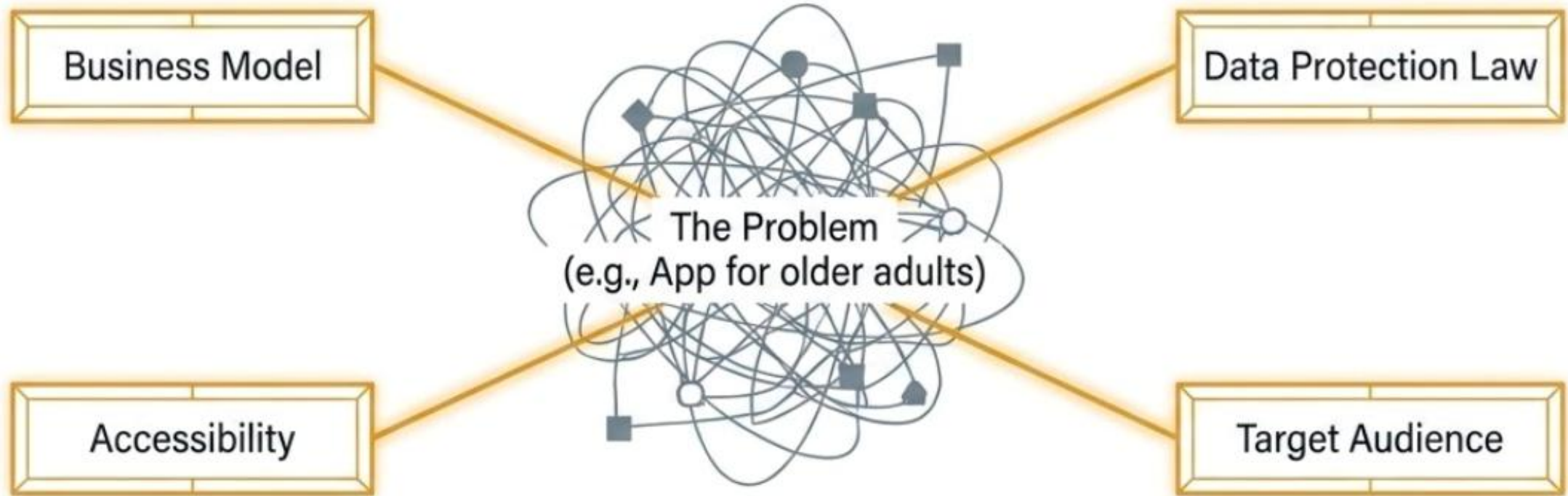
AI teaching & learning agent

Competence

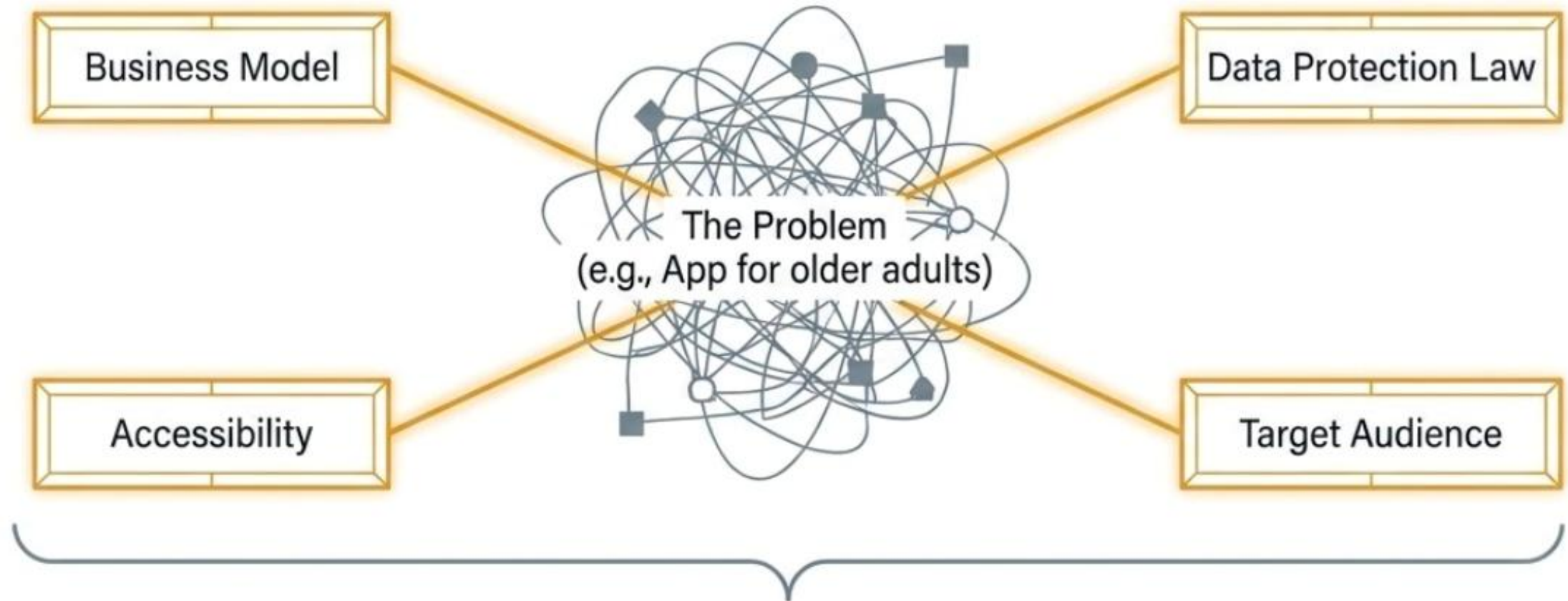
Problem-Based Learning

- real-world projects
- ill-structured problems

For example....



For example....



The PBL effect for GenAI: before AI can answer well, students must know what to ask.

The Sequencing Timeline Metaphor

Learning process

Task

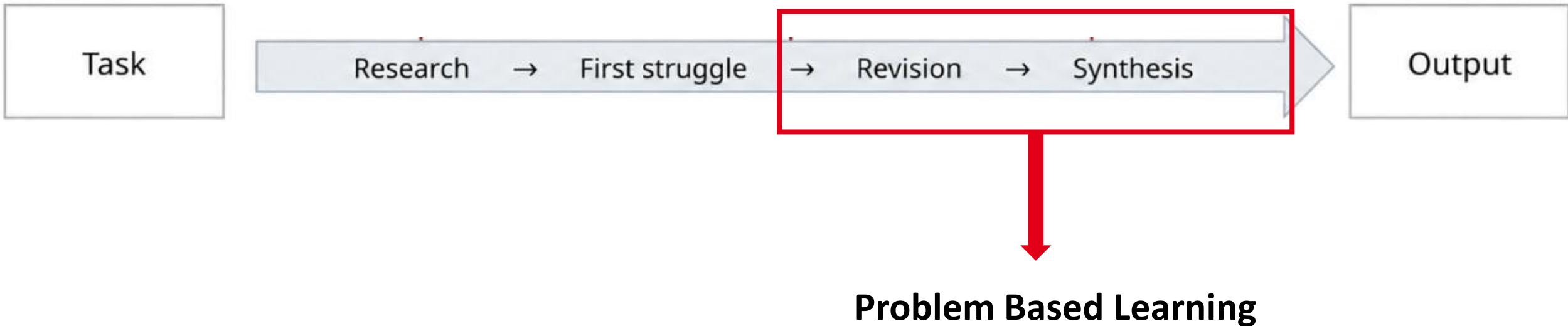
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The Sequencing Timeline Metaphor

Learning process



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Redesign the curriculum

Product-Oriented Curriculum

Predefined tasks

Linear / Arbitrary

Highly susceptible
to substitution

The Trigger

Knowledge
Acquisition

AI Vulnerability

Problem-Oriented Architecture

Authentic,
open-ended problems

Situated / On-demand

Requires independent
problem-structuring

Our (proposed) solution....

Knowledge

WOTUM

AI teaching & learning agent

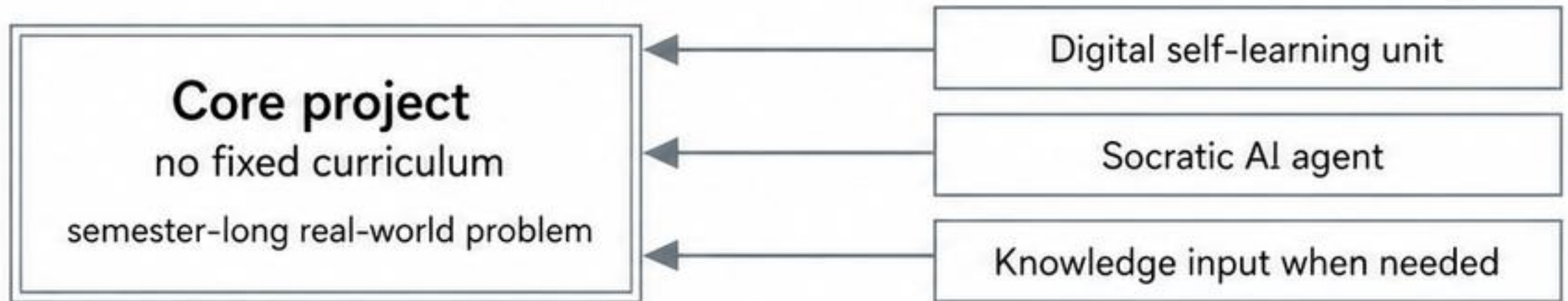
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Competence

Problem-Based Learning

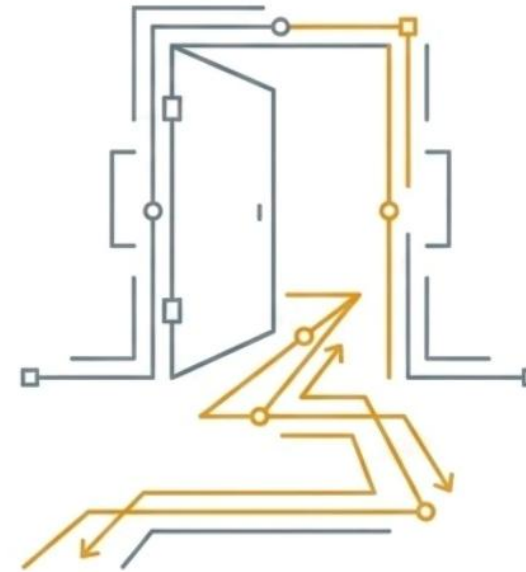
- real-world projects
- ill-structured problems
- students must formulate the question first

Our (proposed) solution....



Takeways?

- > Open-ended problems over fully pre-structured assignments
- > Learning agents over answer machines
- > Didactic guardrails over blanket bans
- > Delaying the solution over delaying the technology



Open-access monograph on higher education in the age of generative AI



What is Lehrwende?

Lehrwende is a scholarly open-access monograph by Roland Böttcher. It examines how generative AI is transforming higher education and why instructors, curricula, and institutions need to respond.



Central perspective

The book focuses on how higher education can be rethought in the age of generative AI — moving beyond mere tool use toward a broader pedagogical and institutional reorientation.



Availability

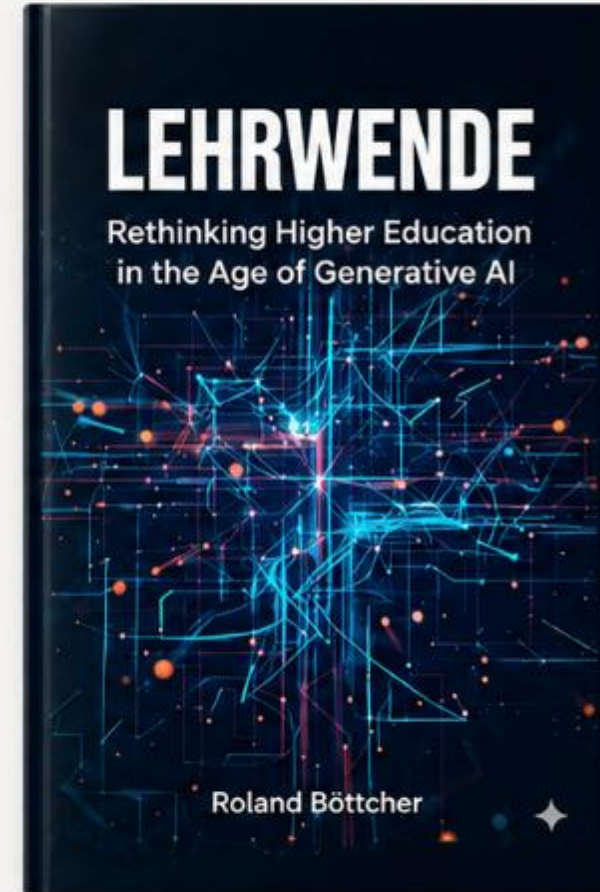
The book is open access and available online as a free download. Both a German edition and an English edition are available.



<https://lehrwende.de/>



Open access – free download available



OPEN ACCESS

References

- Barcaui, A. (2025). *ChatGPT as a cognitive crutch: Evidence from a randomized controlled trial on knowledge retention*. **Social Sciences & Humanities Open**, **12**, Article 102287. <https://doi.org/10.1016/j.ssaho.2025.102287>
- Bastani, H., Bastani, O., Sungu, A., Ge, H., Kabakçı, Ö., & Mariman, R. (2025). *Generative AI without guardrails can harm learning: Evidence from high school mathematics*. **Proceedings of the National Academy of Sciences**, **122**(26), e2422633122. <https://doi.org/10.1073/pnas.2422633122>
- Bjork, E. L., & Bjork, R. A. (2011). *Making things hard on yourself, but in a good way: Creating desirable difficulties to enhance learning*. In M. A. Gernsbacher, R. W. Pew, L. M. Hough, & J. R. Pomerantz (Eds.), **Psychology and the real world: Essays illustrating fundamental contributions to society** (pp. 56–64). Worth Publishers.
- Dochy, F., Segers, M., Van den Bossche, P., & Gijbels, D. (2003). *Effects of problem-based learning: A meta-analysis*. **Learning and Instruction**, **13**(5), 533–568. [https://doi.org/10.1016/S0959-4752\(02\)00025-7](https://doi.org/10.1016/S0959-4752(02)00025-7)
- Farrokhnia, M., Latifi, S., Papadopoulos, P. M., Hogenkamp, L., Gijlers, H., Khosravi, H., & Noroozi, O. (2026). *Generative AI offers more, but students revise less: Comparing the effects of teacher and AI feedback on student essay revisions*. **International Journal of Educational Technology in Higher Education**, **23**, Article 6. <https://doi.org/10.1186/s41239-026-00579-9>
- Hilliger, I., Pérez-Sanagustín, M., Villalobos, E., Ferreira, R., & González, C. (2025). *Scaffolding learning scenarios with a Socratic chatbot: Insights from educators*. In K. Tammets, S. A. Sosnovsky, R. Ferreira Mello, G. Pishtari, & T. Nazaretsky (Eds.), **Two decades of TEL** (pp. 155–161). Springer. https://doi.org/10.1007/978-3-032-03873-9_17
- Hmelo-Silver, C. E. (2004). *Problem-based learning: What and how do students learn?* **Educational Psychology Review**, **16**(3), 235–266. <https://doi.org/10.1023/B:EDPR.0000034022.16470.f3>

References

- Kapur, M. (2008). *Productive failure*. **Cognition and Instruction**, 26(3), 379–424. <https://doi.org/10.1080/07370000802212669>
- Karpicke, J. D., & Blunt, J. R. (2011). *Retrieval practice produces more learning than elaborative studying with concept mapping*. **Science**, 331(6018), 772–775. <https://doi.org/10.1126/science.1199327>
- Kestin, G., Miller, K., Klales, A., Milbourne, T., & Ponti, G. (2025). *AI tutoring outperforms in-class active learning: An RCT introducing a novel research-based design in an authentic educational setting*. **Scientific Reports**, 15, Article 17458. <https://doi.org/10.1038/s41598-025-97652-6>
- Koedinger, K. R., & Aleven, V. (2007). *Exploring the assistance dilemma in experiments with cognitive tutors*. **Educational Psychology Review**, 19(3), 239–264. <https://doi.org/10.1007/s10648-007-9049-0>
- Loibl, K., Roll, I., & Rummel, N. (2017). *Towards a theory of when and how problem solving followed by instruction supports learning*. **Educational Psychology Review**, 29(4), 693–715. <https://doi.org/10.1007/s10648-016-9379-x>
- Mekheimer, M. (2025). *Generative AI-assisted feedback and EFL writing: A study on proficiency, revision frequency and writing quality*. **Discover Education**, 4, Article 170. <https://doi.org/10.1007/s44217-025-00602-7>
- Rismanchian, S., Uzun, H., Matayoshi, J., Cosyn, E., & Kurd-Misto, E. (2026). *Faster completion, less learning: Generative AI reduced study time on math problems and the knowledge they build*. **arXiv**. <https://arxiv.org/abs/2605.21629>
- Slamecka, N. J., & Graf, P. (1978). *The generation effect: Delineation of a phenomenon*. **Journal of Experimental Psychology: Human Learning and Memory**, 4(6), 592–604. <https://doi.org/10.1037/0278-7393.4.6.592>
- Wood, D., Bruner, J. S., & Ross, G. (1976). *The role of tutoring in problem solving*. **Journal of Child Psychology and Psychiatry**, 17(2), 89–100. <https://doi.org/10.1111/j.1469-7610.1976.tb00381.x>