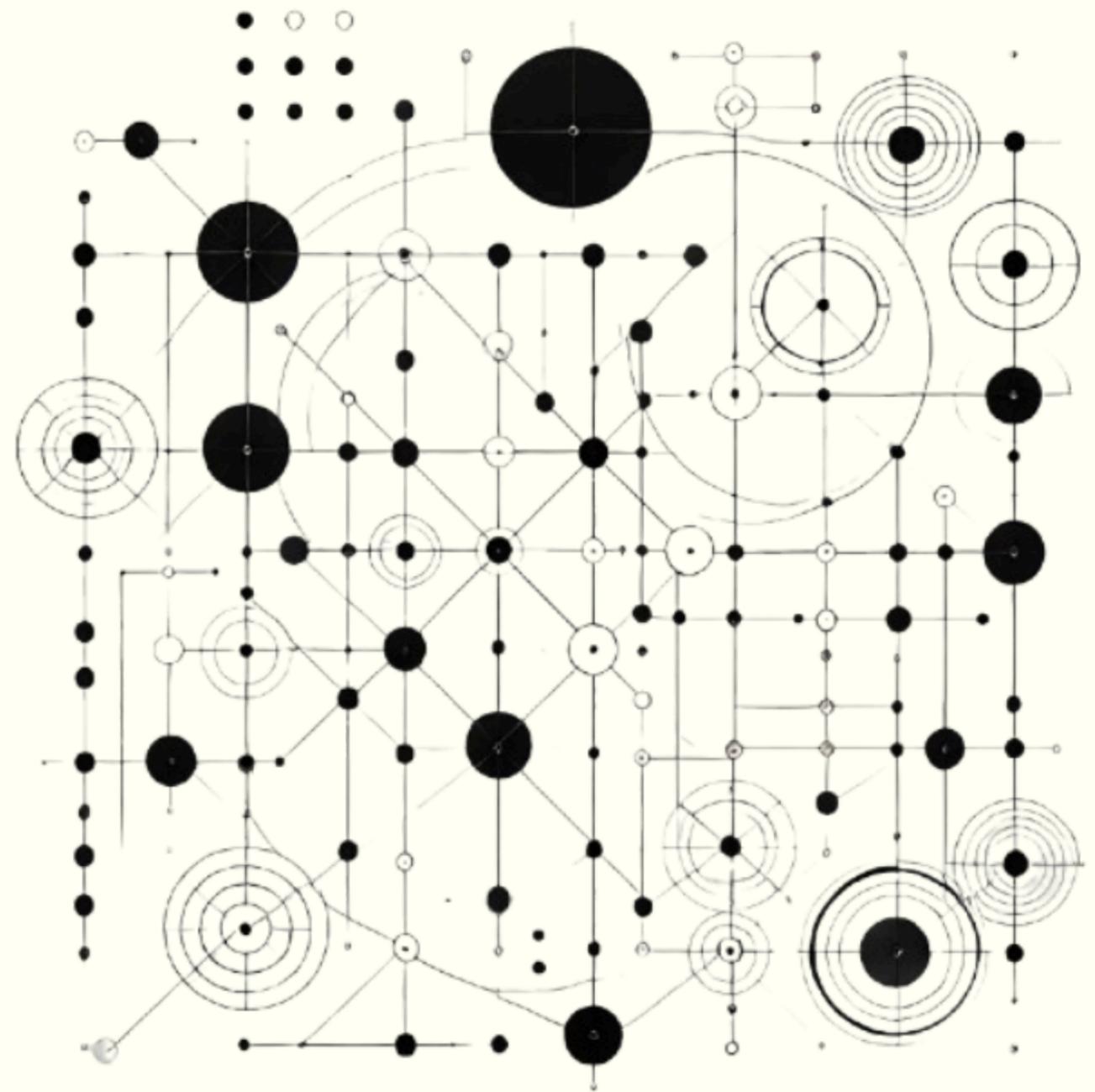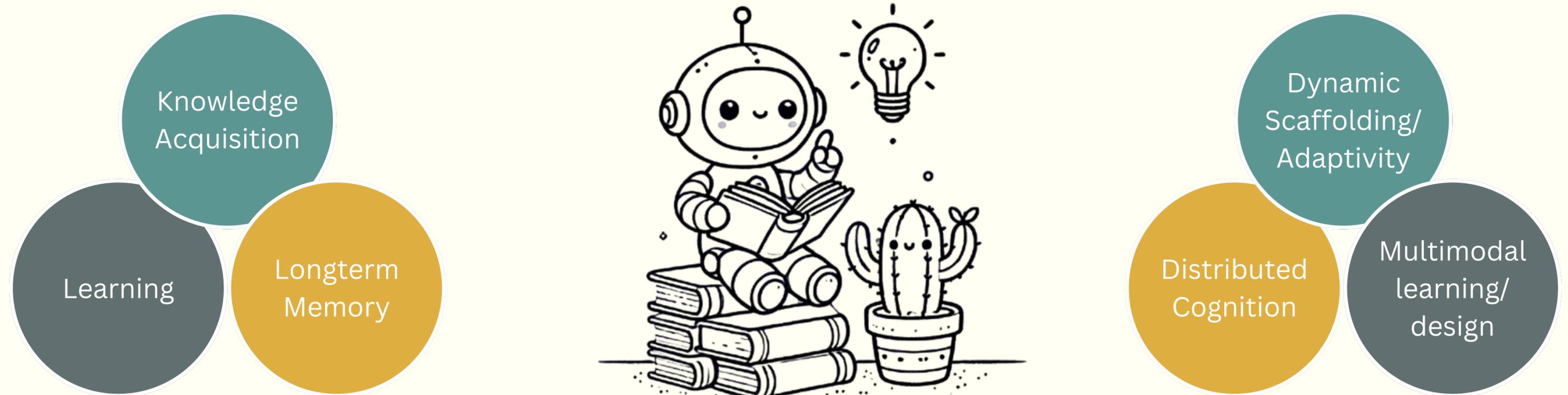# Balancing **Efficiency** and **Depth**: Shaping AI to Shape Better Learning Experiences

Central Question:
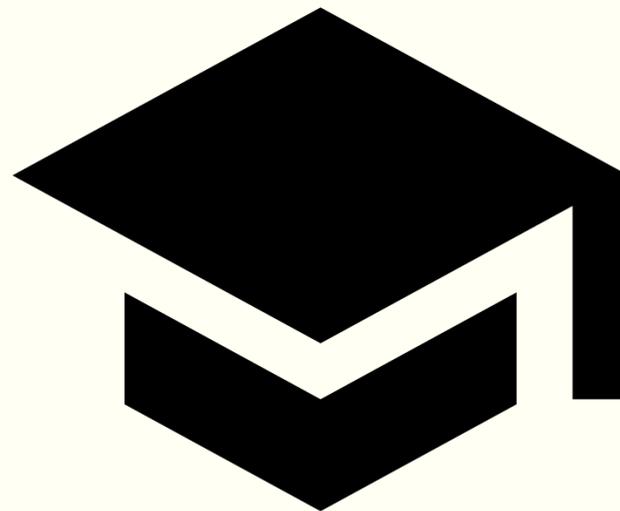
How effective is Chat GPT at promoting and facilitating knowledge acquisition, especially compared to more traditional learning methods?

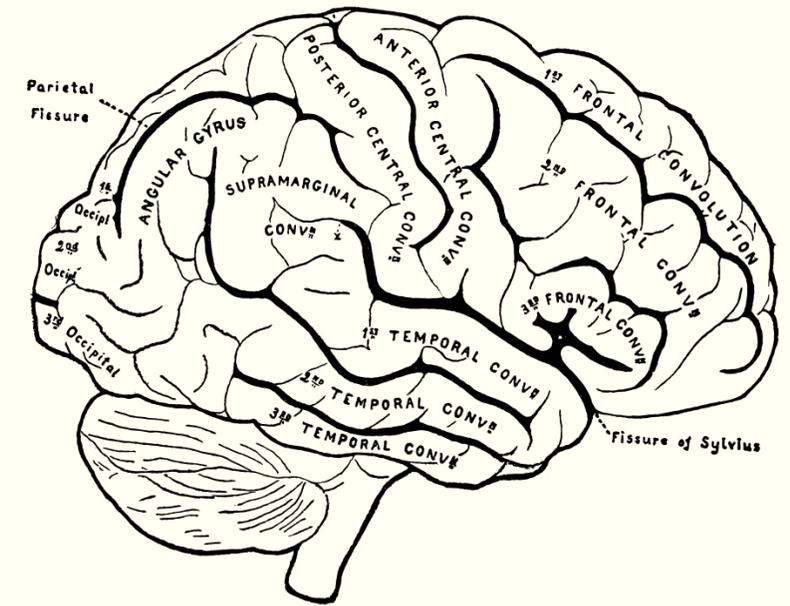Knowledge Acquisition

Learning

Longterm Memory

Dynamic Scaffolding/ Adaptivity

Distributed Cognition

Multimodal learning/ design

Why?

Ubiquity of AI Tools

Possibilities for education

**A new frontier for
understanding cognition**

Cognitive ease at a cost:
LLMs reduce mental effort but compromise depth in student scientific inquiry.

Stadler, M., Bannert, M., & Sailer, M. (2024)

- Examines the relationship between LLM usage and learning outcomes, focusing on cognitive load and depth of understanding.

Findings:
- LLM users reported significantly lower germane cognitive load (GCL).
- Google Search users experienced higher GCL, linked to active schema construction and deeper learning.
- Google Search users produced higher-quality justifications than LLM users.
- LLMs provide concise and conversational answers but lack mechanisms for fostering deeper engagement.
- LLMs reduce mental effort but may compromise deeper learning and understanding.

Design Takeaway: **How can LLMs balance speed and efficiency with the need for reflective, deep engagement?**

Can we delegate learning to automation?
A comparative study of LLM chatbots, search engines, and books.

Yang, Y., Shin, A., Kang, M., Kang, J., & Song, J. Y. (2024)

- Explores ChatGPT as a learning tool compared to more traditional methods. Focuses on "Search as Learning" – the idea that sourcing information itself is a form of learning.

Findings:
- ChatGPT group: Higher short-term cognitive engagement and concept acquisition.
- Book group: Better long-term retention (over two week period.)
- Engagement: ChatGPT was the highest, engagement with books declined over time.

Design Takeaway: **How can designers integrate elements that enhance long-term retention and deep learning experiences?**.

ChatGPT effects on cognitive skills of undergraduate students: Receiving instant responses from AI-based conversational large language models (LLMs)

Essel, H. B., Vlachopoulos, D., Essuman, A. B., & Amankwa, J. O. (2024)

- Explores how using ChatGPT affects the critical, creative, and reflective thinking skills of university students. 125 students were split into two groups: one used ChatGPT for in-class tasks, while the other used traditional methods.

Findings:
- **Critical Thinking:** ChatGPT significantly boosted critical thinking, including openness to new perspectives and reflective skepticism.
- **Creative Thinking:** Students using ChatGPT showed increased creativity, demonstrating better innovation and problem-solving abilities.
- **Reflective Thinking:** ChatGPT fostered deeper self-reflection and understanding of the learning material compared to traditional methods.

Design Takeaway: **How can designers take promote aspects of chat agents that enhance these cognitive processes?**.

Potential Cognitive Risks of Generative Transformer-Based AI Chatbots on Higher Order Executive Functions

U. Leon-Domínguez

Theoretical paper exploring the potential impact of the type and degree of cognitive offloading afforded by tools like ChatGPT on the evolution of human cognition.

The author proposes three hypotheses for how ChatGPT might influence higher order executive functions:

- **Cognitive Zero-Sum Adjustment:** AI tools might not fundamentally alter cognitive abilities, but rather optimize how tasks are approached and processed.
- **Soft-Cognitive Offloading:** AI tools could lead to an effect observed with other technologies, where specific cognitive skills are underutilized, potentially inhibiting their development. Could lead to **hyper-specialization** without regulation.
- **Hard-Cognitive Offloading:** ChatGPT as a fully integrated cognitive prosthetic that could potentially replace high-level cognitive functions like thinking. Loss of autonomy, cognitive atrophy.

Design Takeaway: *Balance between cognitive support and independence is key*. **Promoting cognitive development over offloading.**

synthesis

- As a learning tool, ChatGPT is immersive and engaging: the conversational interface and personalized responses encourage **excitement** and **investment in the learning process.**
- ...*but there are tradeoffs*: compared to traditional learning formats, ChatGPT proved **less effective at encoding learning content in long-term memory.** Why? Search's impact on knowledge formation and self-guidance through material.
- ChatGPT is accessible and its use is becoming ubiquitous -- with such widespread adoption, designers should prioritize environments that **support cognitive development**, rather than **cognitive offloading.**


- The relationship between cognitive development and tool use has been thoroughly explored -- **the *theory of material engagement*.**
- ChatGPT is not only a new tool to consider, but an **opportunity to better understand underlying cognitive processes** like knowledge acquisition and long-term memory, as well as how cognition evolves over time.
- Expanding on ChatGPT's conversational interface, either with prompts based in **pedagogical theory** or via **UX that encourages reflection, creativity, and long-term retention**, can help us abate the "problem of control", promoting user-driven cognitive agency.
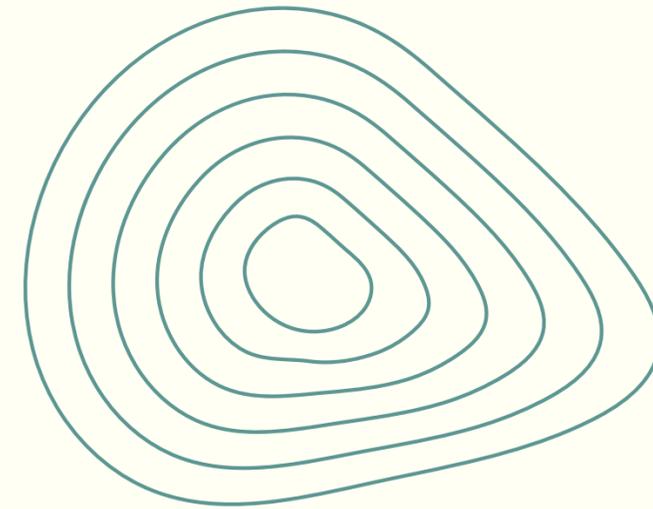
design priorities (provide the user):
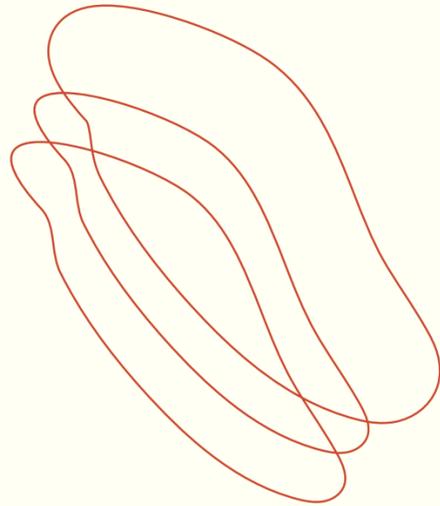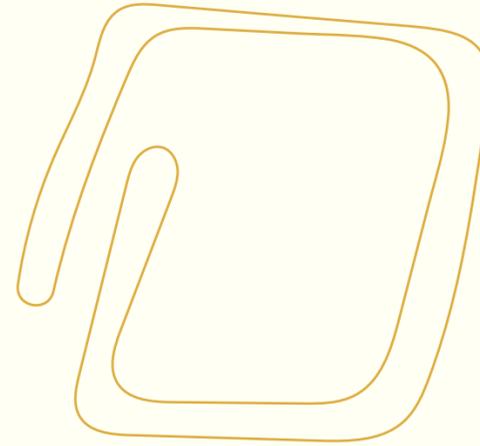
scaffolding   agency   autonomy
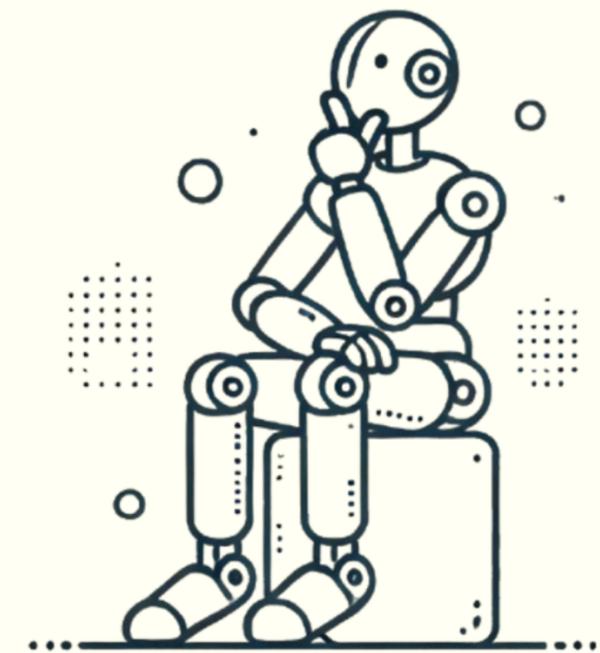
Imagining a tool that:

Leverages the **conversational approach** and **accessibility** of ChatGPT

Facilitates user's **self-guidance** through the material, asking **higher order** questions to encourage **reflection and retention**

Generates **mnemonic artifacts** to encourage long term retention, creating a dynamic repository of relevant content users can **search through** that complements the conversation.

Provides a **personalized learning journey** based on user-**defined goals** and assessed **learning preferences**

Uses **spiraling** and **distributed learning** to lower cognitive load and reinforce key components.

Future Directions

Thank you!