

Potential of Using AI to Improve Student Learning in STEM: Now and in the Future

Brief Remarks



CADRE Learning Series

**Generative AI in STEM Teaching and Learning:
Now and in the Future**

Meet the Panelists:



Thanks for your four-part schema

- AI as Learning Partner for Cognitive Support
- AI as Learning Partner for Metacognitive Support
- AI as Learning Partner for Motivational and Emotional Support
- AI as Learning Partner for Collaboration and Discourse Support



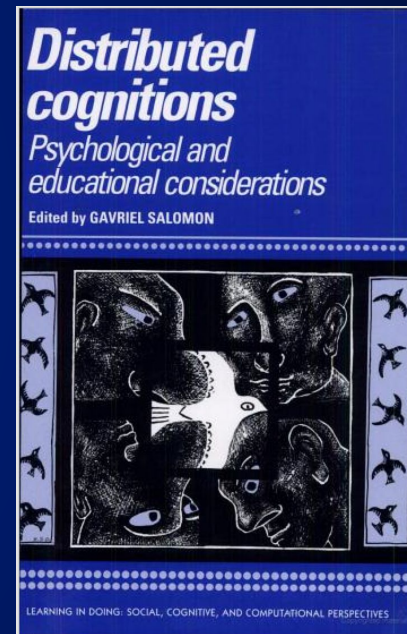
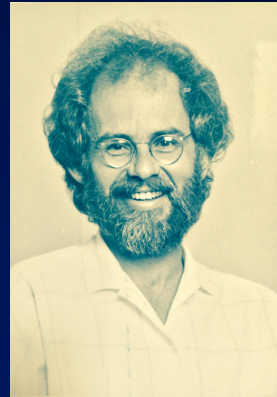
Community for Advancing
Discovery Research in Education

Guide to Commentary

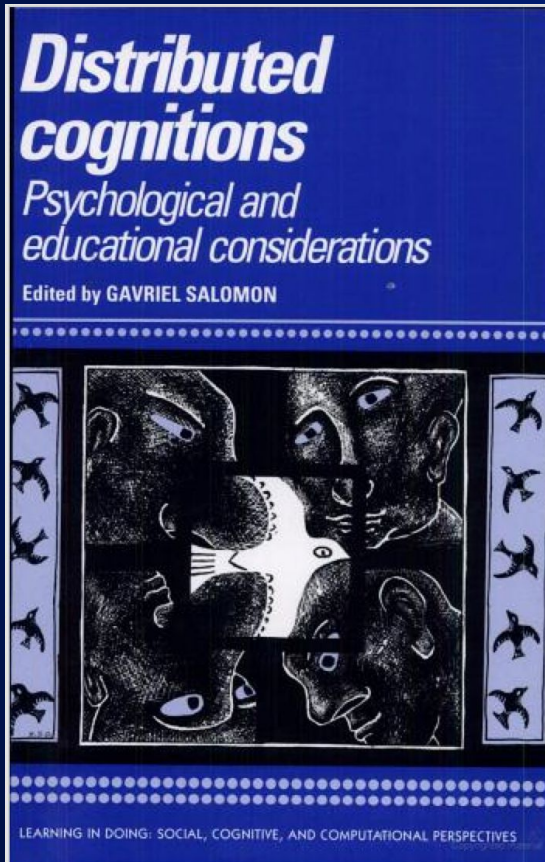
- CADRE orienting questions:
 - “What role can AI play in supporting learners in developing *STEM integrated understanding* & enhancing their engagement and interest in STEM to solve complex or ill-structured problems, make sense of compelling and challenging phenomena, and make informed decisions?”
 - “How can STEM educators leverage AI as a learning partner for students to maximize their cognitive and metacognitive skills, motivation and emotional engagement, and opportunities to effectively collaborate?”
- Backdrop of distributed intelligence
- Several key concerns

Distributing intelligence in design

- “Through processes of design and invention, we load intelligence into both physical, designed artifacts and representational objects such as diagrams, models and plans.”
- “We exploit intelligence from objects when we use them instrumentally in activities.”
- “Once such intelligence is designed into the affordance properties of artifacts, it both guides and constrains the likely contributions of that artifact to distributed intelligence in activity.”



Why does this matter??



- “Culturally valued designs for distributed intelligence in which a learner participates to achieve a specific goal *will change throughout history.*” (1993, p. 71)
- Consider changes in math curricula from an era of Roman numerals; after Descartes invents graphing; with slide rules; with manipulatives; with graphing calculators; **with Generative AI today.**

- Whatever we find as scientists about how the dynamics of distributed intelligence work in learning and education, we are still faced with *the values question of educational aims* - whether they are to foster intelligence that is executed "solo," is tool-aided, or is collaborative, or in what combination for what content domains and activities.
- We are at a point in cultural history where these issues of tool-aided, socially shared cognition must be examined and debated on empirical grounds.
- What designs of distributed intelligence are effective to what ends?
- What are our assumptions about the patterns of distributed intelligence in society into which students must enter and productively use what they have learned?

Several Gen AI in education concerns

- A 'learning partner' without *a theory of mind*
- The 'when' and 'why' of *fading of AI scaffolding* in learning and teaching
- Policy Environment Today (contra-DEI and AI anti-regulatory)

Theory of Mind lacking in Gen AI

- ToM: the cognitive ability to understand that other people have their own thoughts, beliefs, desires, and emotions which may be different from one's own, allowing individuals to predict and explain others' behaviors based on these mental states
- Gen-AI lack of theory of mind especially concerning for role of cultural foundations of learning in education and prospects of bias and inequity responding to learner differences

Fading of AI Scaffolding

- Definition: Scaffolding is a structure and a process, guided in specific form by tacit assessment of a learner's independent capabilities and needs, and mounted *temporarily* on the learner's behalf until he or she can self-sufficiently produce the behavior on his or her own
- Priority: We must attend more centrally to issues of the 'when' and 'why' of *fading of AI scaffolding* in learning and teaching
- Fact: We cannot assume pervasive access for all learners and teachers to Generative AI platforms

Education and Science Policy

- Coping with the Federal Policy Environment Today
- Contra Diversity Equity and Inclusion efforts
- Contra AI regulations on safety and risks
- This important work outlined in the CADRE brief must continue in its progress, but funding research is likely to be more challenging
- CARRY ON!!!!

Thanks for your CADRE Brief!

Implications for design of education

- A principal aim of education ought to be *teaching for the design of distributed intelligence*.
- Such an education would encourage and refine the natural tendency for people to continually re-create their own world as a scaffold for their activities.
- We should strive toward a reflectively and intentionally distributed intelligence in education, *where learners are inventors of distributed-intelligence-as-tool*, rather than receivers of intelligence-as-substance.
- Such learners may be far more ready not only to adapt to change but to contribute substantially to it.

Issues in distributed intelligence

- “The common assumption of solo intelligence as a central goal of education guides the investigation of learning, the cultivation of mental abilities, information processing, the role of misconceptions in the acquisition of new knowledge, and the design of classroom instruction — with relative disregard for the social, physical and artifactual surroundings in which such activities take place.”

Why educators should care

- It is important to observe and acknowledge distributed intelligence because successful learning (that which eventuates in the achievement of activities) often involves it and learning beset with failures often does not.
- Education often results in making far too many people look "dumb" because they are not allowed to use resources, whereas outside of education we all use resources.
- To get close to empowering more learners to do the activities that education should be enabling, intelligence should be recognized as distributed and education should elaborate the design consequences of that fact.

Static vs evolving task definition

- A potential misunderstanding of the concept of distributed intelligence is the notion of distribution as *reallocation*, dividing up cognition among mind, setting, and artifacts. This view is that there is a *fixed quantity* of intellectual work for doing some task and that this quantity can be differentially distributed across persons and environment.
- The concept we're concerned with is *expanding intelligence* - not reallocating it. We ask where the capacity for *innovation* exists in the concept of distributed intelligence, how we may engender *ever more useful designs* for distributed intelligence.
- Having achieved a greater efficiency by off-loading thinking into the design of the world, one then is freed up to continue to invent and innovate.