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Examining the Impact of AI on Schema and Scaffolding in Educator Preparation

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ABSTRACT

Artificial Intelligence is disrupting the educational landscape and is being touted as a catalyst for enhanced learning. This article examines the use of AI as a scaffolding tool to help preservice teachers build new knowledge and skills. It explores how this use of AI impacts their schemas, the mental structures that support learning. When used as a collaborator, AI might allow developing teachers to create more sophisticated and well-structured lesson plans earlier in their training, leading to a more robust and nuanced schema. However, over-reliance on AI could lead to a less developed, or "brittle," schema, preventing the preservice teacher from fully internalizing the underlying principles of instructional design.

Keywords: Instructional design, Artificial intelligence, Cognitive load theory, Schema, Scaffolding

INTRODUCTION AND BACKGROUND

The emergence of sophisticated Generative Artificial Intelligence (AI) has fundamentally disrupted the educational landscape, making it a critical area of focus across K-12 and post-secondary education (Kholifah et al., 2025). This disruption necessitates a swift pivot in pedagogy and policy, particularly within educator preparation programs (EPPs). Instead of treating AI as a challenge to be avoided, thought leaders advocate for recognizing AI as a catalyst for change that must be embraced to cultivate essential future competencies (Watson & Bowen, 2024).

Scaffolding represents a dynamic, temporary instructional intervention designed to bridge the gap between a learner's current capacity and the desired skill level, aligning with Vygotsky's Zone of Proximal Development (ZPD) (Vygotsky, 1978). This strategy necessitates the gradual fading of targeted assistance as the learner internalizes new concepts and gains independent proficiency. Scaffolding techniques are diverse, encompassing content (selecting prerequisite knowledge), procedural (breaking down complex tasks), and metacognitive support (guiding planning and self-regulation) (Van de Pol et al., 2015).

Schemas, or mental blueprints, are complex organizational structures built from prior experience and knowledge. They fundamentally influence how new information is perceived, processed, and encoded into long-term memory (Piaget, 1952). Therefore, scaffolding acts as the mechanism through which instructional input is structured to help learners access existing

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schemas (assimilation), facilitating schema refinement (accommodation) and the efficient construction of durable knowledge (Sweller, 2020).

Typically, EPPs teach preservice teachers instructional design and lesson planning by providing theoretical knowledge, modeling effective practices, offering feedback and planning opportunities for experiential learning. They use frameworks like Gagné's Nine Events of Instruction (Gagné et al., 1992) and focus on explicitly and systematically teaching each component of a lesson: 1. Gain attention, 2. Inform learners of the objective, 3. Stimulate recall of prior learning, 4. Present the content, 5. Provide learning guidance, 6. Elicit performance/practice, 7. Provide feedback, 8. Assess performance, and 9. Enhance retention and transfer. This stepwise approach relies on instructor scaffolding. Instructional design is a high-cognitive-load activity because it requires integrating curriculum knowledge, pedagogical theory, instructional strategies, assessment methods, and classroom management techniques simultaneously. Each component of the lesson plan is introduced with increasing complexity, requiring preservice teachers to synthesize knowledge to design an initial instructional plan and then revise it based on instructor feedback or in response to practical application. This effortful thinking strengthens the preservice teacher's instructional design schema (Sweller, 2020).

According to Van de Pol et al., (2015), scaffolding provides the temporary support needed to bridge the gap between a preservice teacher's theoretical knowledge (e.g. knowing what differentiation is) and the required performance (e.g. writing a specific differentiated activity into a lesson plan). Initially, they are given procedural scaffolding through rigid templates, checklists, or step-by-step guides for sequencing and aligning objectives, activities, and assessments. This reduces the extraneous cognitive load associated with making decisions about format and structure, allowing them to focus their effort on the actual instructional content (Sweller, 2020). The instructor then uses metacognitive scaffolding by asking targeted questions (e.g., "Why did you choose a group discussion over independent reading for this objective?") to prompt the preservice teacher to plan, monitor, and evaluate their own design choices. This guidance is critical in developing a robust schema.

When a preservice teacher creates a lesson plan, they are not just filling out a template; they are building a schema for effective instructional design. This schema organizes their knowledge about learning objectives, learning resources, instructional activities, assessment, and curricular flow into a cohesive, educationally sound unit. As their schema strengthens, they no longer have to approach instructional design as a sequential template. Instead, they can treat the entire process of writing a lesson plan as a single, organized element in their long-term memory. This significantly reduces the intrinsic cognitive load of the task, enabling them to produce complex, high-quality plans rapidly and flexibly (Sweller, 2020). A robust schema allows them to transfer their planning skills across different grade levels, subjects, and instructional contexts. When given a new curriculum standard, they can immediately activate the relevant schema to structure an appropriate teaching and learning sequence, demonstrating adaptive expertise, similar to that observed in a veteran teacher.

THE AI DILEMMA: SCAFFOLDING VS. OFFLOADING

The primary challenge for EPPs is balancing AI's potential to accelerate skill acquisition and the risk of fostering weak, or "brittle", schemas through cognitive offloading (Verma et al., 2025). AI can be used as a tool for scaffolding complex tasks, such as instructional design (Chien et al., 2025). By acting as a collaborative partner (Watson & Bowen, 2024), AI can instantly generate sophisticated lesson plans; successfully reducing the extraneous cognitive load associated with routine tasks. Theoretically, this should free the preservice teacher's working memory to focus on germane cognitive load—the productive effort required for deep learning and schema formation, leading to more robust and nuanced instructional design schemas.

However, this efficiency presents a profound pedagogical risk–cognitive offloading. As Sharma et al. (2025) argue, unguided reliance on AI to complete complex tasks bypasses the effortful thinking necessary for genuine learning. When a preservice teacher allows AI to entirely generate a lesson plan without critical oversight, they accrue "cognitive debt", the missed opportunity to build foundational cognitive assets and internalize design principles.

This reliance can lead to the formation of a brittle schema. While the final product may appear competent (Watson & Bowen, 2024), the preservice teacher lacks the deeply connected, flexible mental structure to adapt that plan when faced with real-world complexities. Their knowledge remains dependent on the external tool, preventing them from being able to critically evaluate the AI-generated content, resulting in errors or bias (Vasconcelos, 2023). They will also be unprepared to swiftly modify instruction in response to student need or diverse classroom contexts. These are essential and critical skills for teaching professionals to be effective in their role.

AI AND COGNITIVE LOAD THEORY

Sweller's (2020) Cognitive Load Theory (CLT) is rooted in the idea that human working memory has a finite capacity, and instructional efficiency is achieved by allocating that capacity to productive learning rather than non-essential tasks. AI has potential to impact cognitive load, specifically reducing extraneous cognitive load (ECL) and facilitating germane cognitive load (GCL). ECL refers to the mental effort imposed by instructional activities that do not directly contribute to schema construction (Sweller, 2020). When a preservice teacher writes a lesson plan, ECL is generated by performing non-essential mechanical work (such as formatting documents or correcting grammatical errors) or when gathering information (such as identifying grade level standards or learning resources). By offloading these low-level functions to AI, the cognitive resources of the preservice teacher are conserved, reducing the ECL.

When working memory is conserved, GCL, the productive mental effort specifically dedicated to schema formation, automation, and refinement is increased. This promotes deep and meaningful learning. By having the AI manage ECL, the preservice teacher can reallocate their freed working memory capacity to focus entirely on the core intellectual challenge of instructional planning for critical evaluation, schema refinement, and adaptive expertise.

Analyzing AI-generated content and critically evaluating its pedagogical "fit" (e.g. developing standards-aligned objectives and assessments) facilitates GCL. Integrating complex theoretical principles (e.g., how to adapt learning resources to meet diverse student need) leads to schema refinement. Implementing the lesson plan in the classroom setting also facilitates GCL by requiring preservice teachers to modify instructional plans based on learning progression and contextual nuance. AI can serve as a scaffold that optimizes the ID process. It can operate by minimizing the cognitive drain of ECL, thereby maximizing the mental resources available for the GCL. This can allow preservice teachers to build a flexible, internalized, and robust instructional design schema. The pedagogical implications of AI use in educator preparation is strongly contingent upon whether it is used to augment preservice teachers' cognitive processes (supporting schema development through scaffolding) or replace them (creating a brittle schema).

THEORETICAL AND PRACTICAL CONTRIBUTION

The primary theoretical contribution of this work is the direct linkage established between Cognitive Load Theory (CLT), schema formation, and the specific pedagogical risks posed by over-reliance on generative AI. The concept of cognitive debt is used to describe the deferred germane cognitive load essential for schema acquisition. AI-driven replacement of intellectual effort results in development of brittle schemas, knowledge structures that are underdeveloped, lack necessary connectivity, and fail to transfer effectively across contexts. In the case of preservice teachers this leads to ineffective teaching practices. By framing this risk in terms of working memory capacity, an explanation of this author's observed deficiencies in learning outcomes due to preservice teachers' overreliance on AI is offered. Understanding and disentangling the fragile balance between scaffolding and offloading, and the related impact on schema development, is crucial for EPPs to be able to effectively teach instructional design theory.

AI can reduce ECL by automating low-stakes tasks such as formatting templates, spell checking, and proofreading, without inhibiting schema formation (Gkintoni et al., 2025). EPPs must rethink how to teach instructional design principles in a way that is AI-supported but still requires uniquely human input (Watson & Bowen, 2024). How can EPPs strengthen instructional design schema using an AI-supported scaffold? Table 1 identifies significant foundational knowledge and skills related to each of Gagné's Nine Events of Instruction, along with practical recommendations for AI use by EPPs that prioritize schema development over simple output generation.

Table 1: Teaching instructional design with AI supported scaffolds.

Gagné's Nine Events of Instruction	Foundational Knowledge and Skill Acquisition	AI to Reduce ECL → Benefit of Use	AI to Facilitate GCL → Benefit of Use
1. Gain Attention	- Recognize that attention precedes learning. - Distinguish between relevant and distracting attention-getters.	Use AI tools to brainstorm anticipatory hooks. → Reduces planning time.	Ask AI to create contrasting case studies or locate relevant media. → Strengthens schema for attention gaining.
2. Inform Learners of Objectives	- Recognize that clear objectives guide cognitive focus. - Differentiate between content topics and measurable outcomes. - Write measurable and aligned objectives.	Use AI to clarify complex objectives or check alignment to Bloom's verbs. → Removes linguistic barriers that consume unnecessary mental effort.	Ask AI to critique student-written objectives ("Does this align with Bloom's level of analysis?") and explain why. → Supports metacognitive reflection on precision and alignment.
3. Stimulate Recall of Prior Learning	- Explain how prior knowledge helps integrate new information. - Identify techniques that make prior learning visible (e.g., concept mapping, discussion).	Use AI to generate structured reflection questions or concept maps. → Saves planning time and ensures focus on relevant recall.	Ask AI to create a concept map of a written lesson plan. → Makes schema activation visible.
4. Present the Content	- Organize information logically (chunking, sequencing). - Differentiate between "telling" and "teaching." - Recognize the importance of multimodal input and cultural awareness.	Use AI to locate and condense texts into digestible summaries or structured outlines. → Reduces extraneous load caused by disorganized or overwhelming materials.	Ask AI to generate multiple examples of concepts to be taught to appeal to diverse learners. → Deepens understanding through comparison and transfer.
5. Provide Learning Guidance	- Use guidance techniques (examples, mnemonics, modeling, self-talk, analogies). - Provide guidance to reduce cognitive load.	Use AI to co-create lesson plan templates, alignment checklists, or guidance prompts so students focus on reasoning rather than formatting. → Minimizes procedural clutter.	Have preservice teachers ask AI, "What guiding questions could help students connect this objective to prior knowledge?" → Encourages deliberate schema construction.
6. Elicit Performance (Practice)	- Recognize why active practice consolidates learning. - Distinguish between guided and independent practice. - Differentiate instruction	Use AI to create tiered resources and activities → Saves time and allows for easier differentiation.	Students can iteratively refine their lesson plan with AI feedback, explaining their reasoning each time → Builds metacognitive awareness and strengthens schema.

Continued

Table 1: Continued.

Gagné's Nine Events of Instruction	Foundational Knowledge and Skill Acquisition	AI to Reduce ECL → Benefit of Use	AI to Facilitate GCL → Benefit of Use
7. Provide Feedback	- Use effective feedback (specific, timely, actionable). - Use formative assessment and monitor progress.	Use AI to co-create formative assessments and rubrics. → Saves time and increases objective feedback.	Have students compare AI-generated feedback to instructor feedback, then discuss why one is more actionable. → Deepens understanding of what quality feedback entails.
8. Assess Performance	- Differentiate between formative and summative assessment. - Align assessments with objectives and instruction. - Use valid and reliable assessments.	Use AI to verify that assessment questions align with objectives and assessments. → Removes extraneous time evaluating alignment manually.	AI can produce different versions of assessments; preservice teachers analyze which best aligns to their objectives and learner needs - Strengthens ability to discriminate cognitive rigor and alignment.
9. Enhance Retention and Transfer	- Promote transfer (reflection, generalization, real-world application). - Recognize that retention is reinforced through varied contexts.	Use AI to adapt a lesson plan for a new grade level or modality (e.g., online, ELL). → Reduces mechanical adaptation work.	Have AI generate "what if" teaching scenarios, preservice teachers anticipate and plan for instructional modifications → Fosters flexible transfer and abstraction.

RECOMMENDATIONS FOR PRACTICE

EPPs should update their curricula to include the principles of CLT, with special attention to designing AI-augmented tasks. This involves training future educators to identify and avoid activities that result in cognitive replacement, emphasizing the creation of learning experiences that require students to process and synthesize, even with AI support. To maximize scaffolding and prevent the formation of brittle schemas, preservice teachers should be expected to design each event in lesson planning before using AI to refine and generate alternative versions of the plan. The creation process must also include evaluation and critique, so errors and bias can be identified and addressed.

Equally important is ensuring that preservice teachers learn with AI in productive and responsible ways. Structured and ethical exposure to AI during preparation programs allows preservice teachers to develop technical fluency and the professional judgment necessary to then teach responsibly in their future classrooms. Learning to design AI-supported lessons will model best practice for them so they can use AI to scaffold student learning, support creativity, and promote critical engagement.

Institutions must develop clear policies that govern the ethical and pedagogical use of AI, prioritizing assessment methods that evaluate the robustness of student schemas rather than "competent" output. This includes investing in professional development focused on shifting from product-based to process-based evaluation.

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