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Incremental Scaffolding to Foster Imagination and Reflective Thinking in Stem Education

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Abstract

Although scaffolding is a well-established pedagogical strategy, its consistent use in STEM education remains limited. Curriculum pressures and the emphasis on correct answers often constrain opportunities for imagination, reflection, and independent reasoning. The proliferation of educational tools can further overwhelm students, reducing adaptability in real-world problem-solving. Recent studies indicate that scaffolding is most effective when students work in pairs rather than larger groups, and that streamlined scaffolding outperforms approaches combining multiple tools, highlighting that excessive support can hinder learning. Building on these findings, this study proposes an incremental scaffolding approach integrating conceptual, motivational, strategic, and metacognitive support through stepwise guidance and reflective prompts, tailored for high school and undergraduate STEM classrooms. Through a mixed-methods pilot involving teacher workshops and classroom implementations, the model guides instructors in applying scaffolding effectively across diverse STEM disciplines, ensuring scaffolds function as temporary support gradually removed as learners develop independent reasoning and creative problem-solving skills. By balancing structured guidance with autonomy, this approach seeks to restore curiosity, reflective thinking, and self-directed learning, providing an evidence-informed framework that is both feasible and scalable for educational reform.

Keywords: Cognitive Overload; Incremental Learning; Metacognitive Scaffolding; Reflective Thinking; Stem Education