Inquiry with Intent: Leveraging the 5E Model to Reduce Cognitive Load in SBAE Lesson Planning

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Introduction/Need for innovation

The 5E learning sequence is widely utilized in science lesson planning but appears to be largely absent from the literature in school-based agricultural education (SBAE). The 5E sequence provides a constructivist learning rhythm through the phases of engage, explore, explain, elaborate, and evaluate (Bybee et al., 2006). Although 5E is not widely discussed in SBAE, inquiry-based instruction (IBI) has been a consistent focus. The documented benefits of IBI, including critical thinking, problem solving, content knowledge, and communication (Skelton et al., 2018; Thoron & Meyers, 2011), all of which closely align with the goals and structure of the 5E model (BSCS Learning, n.d.; Bybee, 2015).

Given the limited presence of 5E in SBAE literature, this innovative idea centers on applying the 5E lesson design framework within SBAE to support student-centered, inquiry-based instruction planning aimed at reducing cognitive load while planning for inquiry-based instruction. SBAE teachers report feeling overwhelmed by the demands of their roles, including curriculum development (Myers et al., 2005). This reality underscores the need for planning frameworks that both align with the constructivist pedagogy foundational to SBAE, and the need to reduce the cognitive burden associated with designing such experiences.

Drawing on Sweller et al.'s (2011) Cognitive Load Theory, we propose that the 5E model can serve as a scaffold for student-centered instructional planning. Beyond simply implementing 5E as a teaching model, this innovation positions the framework as a tool to reduce cognitive load for SBAE teachers while maintaining fidelity to constructivist learning principles.

How it works

Our discussion of 5E is grounded in Bybee's (2015) model, including the conception of iterative explore/explain cycles. Planning begins with backward design (Wiggins & McTighe, 2011). Within that three-stage process, we outline planning instruction with the 5E and corresponding teaching strategies within the context of SBAE.

1. **Engage / Phenomenon / Designing Solutions** - The lesson starts with an authentic problem or phenomenon, supportive of Dewey's (1938) notion of stuck or struck. This is more than a flashy hook (Penel et al., 2016) or a warm-up-type question; it should be contextualized in specific events, relatable to students.
    a. To introduce a phenomenon: use visual stimuli (GIFs, videos, photos, news clips, personal stories), case studies, and data anomalies to spark curiosity and elicit prior knowledge. Then, concurrently or sequentially, support making student thinking visible with the use of KWL charts, "Notice & Wonder" routines, initial models, discussion, quick writes, or other thinking routines.
2. **Explore 1 – Conceptual Foundations** - Prioritize "lab before blab" or "ABC - activity before content" with hands-on/ minds-on experiences to develop conceptual understanding and/or connect with existing schema.
    a. Suggested teaching methods: Conduct labs, demos, simulations (virtual or kinesthetic), observations, exploratory stations, or manipulative activities.
3. **Explain 1 – Thinking Visible 1** - This phase results in a specific artifact that makes student thinking visible from Explore 1.

   a. Suggested teaching methods: Use discussion protocols (e.g., Think-Pair-Share, Four Corners), evidence-based writing (CER), concept mapping, whiteboarding, exit tickets, or student-led debriefs.
4. **Explore 2 – Making Concepts Comprehensible** - Introduce content to support meaning making of the science and agricultural concepts as it relates to the phenomenon.
   a. Suggested teaching strategies: Use media analysis, technical reading, interactive simulations, secondary labs and support with appropriate scaffolding as needed.
5. **Explain 2 – Thinking Visible 2 -** Students refine understanding; apply vocabulary and evidence from one or both explore phases to explain the lesson phenomenon.
   a. Suggested teaching methods: explanations, infographics, student presentations, class discussions, Socratic seminars, or visual representations (diagrams, timelines, flowcharts). Provide feedback rubrics for clarity.
6. **Elaborate – Digging Deeper or Transfer -** Deepen applied learning with the phenomenon, or test transfer to a new context/phenomenon.
   a. Suggested teaching methods: Use design challenges, debates, problem-solving scenarios, projects, student-led investigations, or complex data analysis.
7. **Evaluate – Final Thinking Made Visible** - Students demonstrate understanding of the agricultural phenomenon with desired content connections between agriculture and science. Provide clear rubrics, peer/self-assessments, and opportunities for revision.
   a. Suggested teaching methods: Use performance tasks, explanatory models, multimedia products, written arguments, or presentations, learner-designed tasks.

Results to date/Implications

At [institution], preservice teachers (n = 26) are taught to utilize the 5E learning frame in their teaching methods courses and practice utilizing it within their full-time clinical practice placements. The 5E lesson design can apply to most SBAE contexts but is especially well-suited for courses addressing or supporting the Next Generation Science Standards (NGSS) (National Research Council, 2013). Past and present, we supervised student teachers who are using the 5E model to plan for secondary agricultural biology, chemistry, mechanics, animal science, and others. As teacher educators, we have noted that the frame helps to support the development of student-centered teaching methods, and has reduced the frequency and duration of direct instruction and other low cognitive demand teaching methods.

Future plans/Advice

We believe two key texts can help to develop skills within planning using the 5E model. As individuals consider implementing 5E, we suggest reading the *5E Model of Instruction* (Bybee, 2015). It provides specific examples of what the teacher and student are doing in each phase, and the nuances involved with implementation. While *Ambitious Science Teaching* (Windschitl et al., 2020) does not explicitly mention the 5Es, it does provide a practical guide to implement student-centered methods, which are necessary for implementation of 5E.

Costs/Resources

The cost of implementing the 5E lesson frame within SBAE is related to the context of the educator who is planning to implement it. Direct costs might include professional learning (varies) and materials to facilitate planned 5E lessons (varies). Indirect costs are related to the time it takes to revise course outlines and prepare teaching materials, which vary by context.

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