Science Strategy Interventions

Strategies and strategic processing within science education are designed to help students learn not only what scientists have come to understand about the world but also how they learn it. Although many domain-general strategies can be implemented in science classrooms, some strategies are either specific to science or are encouraged within science (i.e., the focus of this presentation). Historically, concept development and conceptual change approaches, as well as investigations, dominated science's strategies and strategic processing. Concept development and conceptual change strategies were based on the notion that an individual's conceptual knowledge formed and changed similarly to how scientists constructed and changed scientific explanations (e.g., explanatory hypotheses and theories). Such strategies often sought to initiate cognitive dissatisfaction with learners' pre-existing understanding, and then move learners linearly and rationally through steps that promoted knowledge reconstruction consistent with scientific understanding (see for, example Posner et al., 1982). Similarly, empirical investigation strategies were based on a model of cyclical scientific inquiry, where students interacted with phenomena in a mode of observation to generate questions, made sense of these interactions by either constructing or being provided an explanation, and then applied these explanations to other contexts and phenomena (Karplus & Butts, 1977).

More recently, argumentation and science as modeling dominate the strategies and strategic processing within science teaching and learning. These strategies emerge from earlier modes and attempt to develop learners' scientific expertise. Scientific argumentation is an inherently constructive process, and as a science learning strategy, builds upon the notion of cognitive and social construction of evidence-based explanations (Nussbaum & Edwards, 2011). The science as modeling strategy extends the use of models (including physical, pictorial, graphical, mathematical, and computerized replications of phenomena) to the central focus in inquiry-based learning (Windschitl et al., 2008). Much like other strategies that require higher-order thinking skills, argumentation, modeling, and scientific inquiry may be quite difficult for students to learn and for teachers to teach. Because of this difficulty, instructional scaffolds may be required; examples include the use of computer-based tools to promote scientific thinking (Greene et al., 2012), employment of teacher moves to promote scientific discourse and argumentation (Li et al., 2016), and use of Model-Evidence Link diagrams (Chinn & Buckland, 2012; Lombardi et al., 2018a, b).

The existence of scaffolds and curricula designed to facilitate either argumentation or science as modeling should support teachers in moving toward using these strategies more often, but there may be additional challenges in simply getting such supports into teachers' hands. Teacher education and professional development programs should seek to explicitly implement contemporary science strategy interventions to improve upon their use in K-12 classrooms and other learning environments. Researchers and designers need to create instructional scaffolding that supports effective employment of science learning strategies, as well as learning opportunities for educators to become well-versed in these strategies.

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