"EMPOWERING CONCEPTUAL CHANGE: STRATEGIES FOR ENHANCING SCIENCE EDUCATION"

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Conceptual change, as proposed by Duit and Treagust (2003), is a powerful framework that holds significant promise for enhancing science teaching and learning. It revolves around the idea of restructuring students' pre-existing conceptual structures to enable a deeper understanding of scientific concepts. Given that much of science is counterintuitive, students often need to challenge their natural understanding of the world, making conceptual change particularly relevant in science education (Cobern, 1996). In this account, this article delves into various strategies that have proven effective in fostering conceptual change in science education, emphasizing socio-constructivist learning environments, technology-enabled active learning, formative assessment, and the Predict-Discuss-Explain-Observe-Discuss-Explain (PDEODE) activity.

One of the key strategies in promoting conceptual change in science is the creation of socio-constructivist learning environments. These learning environments emphasize active engagement, collaboration, and knowledge construction through social interactions. In such settings, students are encouraged to participate actively in their learning process, engaging in discussions with peers and instructors, and constructing knowledge together. By doing so, students can expose their misconceptions and refine their understanding through dialogue and reflection. Research has shown that socio-constructivist approaches not only improve conceptual understanding but also positively influence students' attitudes toward science concepts (Ibañez & Pentang, 2021).

Furthermore, technology-enabled active learning has emerged as another potent strategy for facilitating conceptual change in science education. Integrating carefully

crafted learning environments with technology can offer unique opportunities to enhance students' grasp of scientific concepts (Dori & Belcher, 2005). Virtual learning simulations, for instance, have proven to be highly effective tools for promoting knowledge acquisition and skill development, while simultaneously facilitating conceptual change as effectively as traditional teaching methods (Thisgaard & Makransky, 2017). By immersing students in realistic scenarios, simulations allow for hands-on experiences and exploration of scientific phenomena in a controlled and safe environment, enabling better conceptual understanding.

Formative assessment is an additional crucial approach in supporting conceptual change in science education. By incorporating formative assessment formally into the learning process and introducing multiple cognitive conflicts, educators can challenge students' misconceptions and reinforce accurate scientific conceptions (Srisawasdi & Panjaburee, 2015). Formative assessment empowers students to recognize and address their misconceptions, paving the way for a more profound comprehension of science concepts. As students actively engage with the feedback provided, they become aware of their cognitive gaps, leading to the necessary cognitive restructuring that facilitates conceptual change.

The Predict-Discuss-Explain-Observe-Discuss-Explain (PDEODE) activity stands as an effective teaching strategy to promote conceptual change in science (Coştu et al., 2010). This approach involves a multi-step process, starting with predicting and discussing phenomena, followed by explaining and observing the same phenomena, and concluding with further discussion and explanation. By encouraging students to predict and discuss before observing, the PDEODE activity compels them to confront their preconceptions, engage in active sense-making, and construct a more accurate understanding of scientific concepts. Through this iterative process, students continually refine their understanding, leading to more profound conceptual change.

To summarize, several powerful strategies can aid in promoting conceptual change in science education. By creating socio-constructivist learning environments, educators encourage active engagement and knowledge construction through collaboration. Integrating technology-enabled active learning provides students with immersive experiences and opportunities to explore scientific concepts in controlled environments. Formative assessment helps students identify and address misconceptions, fostering a deeper understanding of science. Lastly, the PDEODE activity prompts students to challenge their preconceptions actively, leading to a more profound and lasting conceptual change. Embracing these strategies can transform science teaching and learning, enabling students to break free from intuitive notions and construct more accurate mental models of scientific phenomena. As educators continue to refine and integrate these approaches into their practice, the potential for conceptual change in science education will undoubtedly flourish.

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