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Metacognition in Science Education: Trends in Current Research

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Аннотация
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Although research about metacognition and its implications for learning and instruction have become a central issue in education, and have provided valuable insights for improving student learning, concerns have been raised about its lack of coherence, and the fact that the term means different things to different people. The editors and chapter authors of Metacognition in Science Education attempt to reduce much of the ambiguity associated with this field of research by providing an integrated view of metacognition. The chapters are written by established scholars in the field of metacognition and make stimulating reading. Overall, the book provides a comprehensive and detailed background on metacognition, and a clear perspective of recent research studies that testify to the value of metacognition for science learning.

The book consists of an introductory chapter, eight chapters that describe research-based trends concerning metacognition in physics, chemistry, biology, and environmental education, and two chapters (chapters two and eleven) on theoretical aspects of metacognition. In chapter two, ‘Metacognition in Science Education: Definitions, Constituents, and Their Intricate Relation with Cognition,' Marcel Veenman provides a general introduction to metacognition and a comprehensive review of its place in science education. He also provides a clear, concise and coherent review of how metacognitive skills are enacted in reading text, problem solving, inquiry learning, and writing; processes that are also explored in other chapters.

Stephen Norris and Linda Phillips provide a comprehensive review of studies on the role of metacognition in reading scientific texts in chapter three, ‘Reading Science: How a Naive View of Reading Hinders So Much Else'. They point out that extensive metacognitive thinking skills are necessary in order to achieve more sophisticated levels of reading, i.e., where meaning is inferred through analysing, interpreting, and critiquing. The chapter concludes with several practical recommendations for writing textbooks and for learning and instruction in the science classroom. In chapter four Gregory Schraw, Lori Olafson, Michelle Weibel and Daphne Sewing present data that link different types of metacognitive knowledge to attitudes and knowledge scores in a field-based science learning experience for 4th and 5th grade students. The results suggest that metacognitive knowledge is an important component of science learning and is related to higher attitude and knowledge scores. The chapter concludes with several suggestions for improving metacognitive knowledge in younger students.

Tina Grotzer and Sarah Mittlefehldt discuss the role of metacognition in the learning of complex science concepts such as density and pressure in chapter five. They argue strongly that in order for concept formation to take place, learners need an awareness of types of causal patterns and their features. They also explore the power of metacognition in helping students to reflect upon and revise their underlying causal assumptions to improve science learning. In chapter six, David Whitebread and Valeska Grau Cardenas explore the connections between metacognition and other constructs, namely self-regulated learning (SRL), intentional conceptual change, and motivation. This chapter begins with and extensive review of literature on theoretical and methodological perspectives on the study of self-regulation of learning and conceptual development in science, and discusses a study where these theoretical relationships are explored.

In chapter seven Jennifer Chiu and Marcia Linn explore how instruction can be designed to help students monitor and regulate their understanding of chemistry when learning with visualisations. The chapter describes two studies, firstly, a self-assessment study, which investigated how learners judge their understanding before and after explanation prompts for visualisations, revealed that students typically overestimated their understanding of visualizations and only realised gaps in their knowledge when they were prompted to explain what they observed. In a second study they highlighted how prompts for explanations motivate students to monitor their understanding and often revisit the visualizations to refine their ideas. These results underscore the importance of both cognitive and metacognitive skills for making sense of visualizations.

Chapter eight by Grit Herscovitz, Zvia Kaberman, Liora Saar and Yehudit Dori investigates the implementation of a metacognitive tool used by high school chemistry students in two related studies. The tool, which includes a three-component taxonomy of content, thinking, and chemistry understanding levels, enabled students to assess the quality of the questions that they had posed. In the first study the Case-based Computerized Laboratory (CCL) environment exposed students to reading case studies. Students were then asked to pose questions and assess their quality according to a given classification in order to investigate their comprehension of adapted scientific articles. Based on these studies the authors conclude that the metacognitive tool developed for use by students for posing complex questions enhanced their scientific understanding.

In chapter nine Anat Zohar examines the claim that adding metastrategic knowledge to routine instruction of higher-order thinking in the science classroom contributes to the development of students' reasoning skills. The author achieves this through an integrative review of studies. Thereafter, the findings of a professional development study on metastrategic knowledge which reveals that teachers who originally lacked the ability to teach higher order thinking skills can make considerable progress in terms of applying metastrategic knowledge in the classroom, is considered.

In chapter ten Osnat Eldar, Bat-Sheva Eylon and Miky Ronen describe a geometrical optics course for pre-service elementary science teachers which attempts to promote subject content knowledge and pedagogical content knowledge by using metacognitive teaching strategies. The results of the study indicate that the pre-service teachers developed a high level of conceptual understanding and diagnostic capabilities that goes beyond what is normally achieved in traditional courses.

Carole Ford and Larry Yore examine the relationships between metacognition, critical thinking and reflection in chapter eleven. While describing several studies on these constructs they emphasize the ‘fuzziness' in terms of their relationships and argue that an integrated view is potentially more powerful than treating each of the constructs separately. They end the chapter by offering a model for construct convergence.

This book is highly recommended for a wide readership as it provides a valuable resource for college or university teaching of metacognition, an important area in science education. It clearly highlights the implications of metacognition research for science learning and teaching and provides meaningful insights for classroom practitioners. In terms of further research, the discussion of recent studies is informative and should prompt ideas for further studies.