

VISUAL-SPATIAL MODES IN SCIENCE LEARNING

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Visual and spatial thinking is an integral part of doing and learning science. The models or idealisations of science are simplifications of complex, real-world phenomena, often expressed in concrete, visual or symbolic modes. Visual imagery and non-verbal, spatial models have been reported in significant discoveries, while in the communication of ideas in science we use photographs, diagrams at various levels of abstraction, and narration of visual experiences. Visual methods continue to be formulated in pedagogy too, yet a principled basis for these methods is lacking. Although visual thinking is studied in the psychological laboratory and through documentation of the practice of science, this phenomenon has remained elusive for educational research generally and for science education particularly (Mathewson, 2005).

I begin this review with the theme of creativity and discovery and its relation with mental imagery, as explored through cognitive science research. Touching upon the link between imagery and memory, I go on to consider the role of the visual in the communication of ideas in science. What is interesting, from the perspective of science learning, is to see how semantic content can be integrated into visual representations, in order to bring about meaningful learning.

A particular strength of visual representations, both internal mental ones and external diagrams and concrete models, is that they are amenable to transformations. I review the evidence for transformational reasoning in science, linking this research with cognitive analyses of mental transformations and use of diagrams for transformational reasoning by children and adults. I identify transformational reasoning as a crucial component in the process of making meaning through visual representations.

I illustrate these ideas through the description of two ongoing research programs at HBCSE. The first program is concerned with middle school students' visual representations in learning human physiology. A central issue in understanding human body systems is the correlation of anatomy with physiology - of structure with function - which in turn involves correlation of diagrammatic representations with text. Visual and transformational reasoning are needed for such understanding.

The second program involves study of students' mental models in elementary astronomy. Understanding of the sun-earth-moon system and of the visible planets and stars calls for transformation between locally perceived phenomena and learnt models and facts about the solar system. The rationale for this research is described.

References

Mathewson, J. H. (2005). The visual core of science: definition and applications to education. *International Journal of Science Education*, 27 (5), 529-548.