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Representational issues in children’s learning about evaporation
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Background of the research, and aims

This study draws on recent research on the central role of representation in learning. While there has been considerable research on children’s understanding of evaporation, the representational issues entailed in this understanding have not been investigated in depth. The study explored students’ engagement with science concepts relating to evaporation through a variety of representational modes.

Over the last twenty years there has been considerable research interest in identifying factors that affect children’s understanding of evaporation, as well as proposals for when and how various learning challenges might be met (Osborne & Cosgrove 1983; Russell, Harlen & Watt 1989; Bar & Galili 1994; Tytler 2000; Tytler & Peterson 2004). Children usually engage with this topic through learning about the water cycle, creating challenges for understanding interrelationships of entities such as the sun, heat, surfaces, atmosphere and clouds as well as complex scientific views about air and matter. Following Piaget (1930) and others, much past research has drawn on a conceptual change or progression approach to children’s understandings, where children are expected to pass through recognizable, predictable stages of explanatory conceptions.

There is growing recognition in science education research that science as a discourse is a mix of languages entailing multi-modal forms of representation, where linguistic, numerical, and graphic and tabular modes are integrated to represent scientific explanations (Lemke 2000; Russell & McGuigan 2001; Unsworth 2001). This implies that learning science effectively entails understanding different representations of science concepts and processes, being able to translate these into one another, and understanding their coordinated use in representing scientific knowledge. At primary school level children need to be introduced to multiple and multi-modal representations of science concepts and be able to understand, translate and integrate these representations as part of learning the nature of scientific knowledge, inquiry, and reporting.

In this paper we draw on the literature outlined above to provide an interpretive lens for analysing a number of upper primary school children’s engagement in a classroom program on evaporation, and their representations of evaporative phenomena during interviews over an extended time period. The research questions guiding the study were as follows:

1. What representational challenges do children experience in engaging with particulate accounts of evaporation?

2. In what ways can this focus on representational issues contribute to current understandings of students’ conceptual learning?

3. What are the implications of insights into the role of representation, for teaching and learning science?
Research design

Drawing on a qualitative methodology (Denzin & Lincoln 1995) involving analysis of children’s drawings and transcripts of interviews, children’s emergent understandings of evaporation were explored. A sequence of classroom activities was devised to provide an instructional context in which children’s ideas were probed and challenged. As part of this sequence a molecular model was introduced as a potential representational resource and explanatory framework, and classroom discussion focused on using this to interpret aspects of phenomena such as boiling water, condensation, and the distribution of eucalyptus oil scent around a room. Students were asked to interpret these phenomena using diagrammatic representation, written captioning, and verbal explanation, and to integrate these representations.

In follow up interviews, 12 children were presented with a variation of these activities and asked to represent them in the different modalities, and challenged by the interviewer to elaborate and refine these representations and their conceptual meaning. One year later, 8 of these children were again interviewed concerning using a similar protocol but with further extensions. Transcripts of these interviews were used to explore the way in which this negotiation of representational meaning:

- Provides insight into children’s current thinking about these phenomena
- Enables children to clarify and refine their emerging conceptual understandings
- Can provide insight into how, in science, representational resources and modes are used to construct scientific explanations

Findings

Analysis of the classroom sequences indicated a number of learning challenges concerning evaporation which could be productively cast as representational issues. For example, the children’s drawings of evaporation often echoed a highly determined pattern of movement associated with their prior understandings of the water cycle. In the interviews this conceptual problem of overdetermination of molecular movement became apparent as a representational issue, with some children, in attempting to represent this pattern in a drawing, wanting to indicate a causal pattern based on localised interactions of particles with the nose. The interview transcripts nevertheless demonstrated how this view could be refined through renegotiation of the representation through interviewer prompts and subsequent drawing alterations and verbal re-representation. In this way, the study indicated how a focus on the children’s attempts to represent their emerging understandings can provide teachers with strong evaluative insights into children’s thinking, and can open up possibilities for teachers to probe children’s ideas in a highly focused, generative way.

This focus on representational challenges has provided a sharper insight into the possibilities and constraints offered by molecular models than has hitherto been reported in the literature. For instance, both the classroom conversations and interviews based around moving between representations of evaporation showed the difficulty students have with causal arguments based on distribution and chance. The study indicated that interactions with students around representations can also enable students to identify the adequacy of their representation for expressing their ideas, and allow the teacher to trace
the emerging collective understandings of the class.

This was also apparent in analysis of students’ conversations around their representations a year later. A comparison of children’s representations on the two occasions showed consistency and growth in the way they represented their understandings, but also considerable variation. The focus on representation allowed insights into the nature of the conceptual challenges children faced, and their developing understandings.

The study also indicated that students need to develop an understanding of the signifying rules of their own representations, as well as those of more conventional science languages (verbal, mathematical and visual) if they are to engage effectively with learning how to interpret and represent science concepts. For instance the representational challenge associated with air pressure phenomena was quite different to evaporation.

Implications

The study indicates how a focus on representation can provide fresh insights into the conceptual task involved in learning science, and suggest that teacher-mediated negotiation of representational issues as students construct different modal accounts can support enriched learning by enabling both a) richer conceptual understanding by students and b) enhanced teacher insights into students’ thinking. The longitudinal element of the study also showed the fruitfulness of a representational focus in supporting and evaluating children’s learning, and making sense of learning over time.

The study suggests that children’s advancement in understanding of evaporative phenomena as involving the uptake of vapour in air is fundamentally a representational issue, and that a molecular distribution representation is fundamental to the capacity to imagine how this might be. The study also suggests that a focus on representational issues provides a powerful pedagogical framework for supporting students’ learning as they attempt to understand the nature of scientific representational discourse (languages of science). The study implies the need for an increased focus on this dimension of meaning making in learning science, and provides new insights into student understanding and student learning in terms of representational knowledge and choices in developing meaning. This emphasis on representational modes and choices allows fresh perspectives on difficulties presented by molecular models as an explanatory framework for understanding evaporation.

References


Jong (Eds.), *Learning with Multiple Representations*. Amsterdam: Pergamon.


