Chapter 12
Theoretical and Conceptual Insights – Representations in Science

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Abstract This final chapter for the third part of the book illustrates the key points made in the chapters of this book and discusses these within the framework of cultural-historical theory. Semiotic mediation of cultural tools and practices in the differing forms feature in this section. In science, and science education, mediation is more commonly referred to in terms of 'representation'. Taking a cultural-historical perspective, cultural tools such as graphic data or speech, do not simply re-present phenomena and processes, they also constitute these in distinct manners for various purposes in different activities. Different mediation not only 'map' different aspects of something, but mediation contributes to how we conceive this 'something' to be.

Keywords Semiotic mediation • Representation • Cultural tools

In this chapter, we will point out some key points of the chapters in this section of the book and discuss these within the framework of cultural-historical theory. In different ways, these chapters all concern the issue of semiotic mediation (Wertsch, 2007) of cultural tools and practices. In science, and science education, mediation is more commonly referred to in terms of 'representation'. Taking a cultural-historical perspective, cultural tools such as graphic data or speech, do not simply re-present phenomena and processes, they also constitute these in distinct manners for various purposes in different activities. Different mediation do not only 'map' different aspects of something, but contribute to what we conceive this 'something' to be. A simple but effective illustration of this theoretical notion is given by Säljö (2000):

> If we think about a simple object such as an ordinary stone, it may appear simple enough to define and describe this object; we can weigh it, measure it, describe its colours and so on, and in these ways make, as it appears, an entirely exhaustive and 'objective' description of the stone. Thus, the problem of referring would be solved once and for all. However, in a sociocultural [aka cultural-historical] perspective, it is obvious that such a description of the stone, no matter how thorough, would still not embrace how the object is apprehended in different human activities and social practices. What is interesting about the stone varies between different human activities and we use it in different ways. (Säljö, 2000, p. 92, our translation)

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He goes on to illustrate his reasoning in the following manner: A stone on a lawn could be used as a goal post during a football (soccer) match; if we need to hammer a nail and do not have a hammer, we could use a stone; it could be used as an object to throw in a fight, as ornament or as an object with extra-human (deity) importance (Säljö, 2000). These, and many other possible uses of a stone, constitute it in different activities as different kinds of objects. These are not merely different aspects of the same stone; in many of these cases, the object is not – within its situated activity – a stone (but a goal post, a weapon etc.). This example may appear to be a long way from the theme of the present book, children learning science. However, familiarizing oneself with a new domain of knowing, among other things, means to learn to constitute phenomena in new and often unfamiliar ways, for example, to see features of animals as characteristics of evolutionary processes or see a cat as a predator (rather than as a pet or simply an animal). New ways of constituting phenomena and processes, as characteristic of scientific knowledge, means to conceive of these in terms of a new set of concepts. Concepts are in a sense decontextualized from here-and-now; they carry meaning over and beyond particular instances.

Developing conceptual understanding in a strict sense is much demanding of the learner (child and adult alike) and probably much rarer than we may think. Vygotsky (1998) uses the distinction between 'pseudo concepts' and 'concepts (proper)', arguing that the former means to generalize on the same level of abstraction, for example, being able to give additional examples of animals, without mastering the concept in a strict sense, that is, being able to clarify what an animal is. Even as adults, we can often give additional examples of something, for example, sports (swimming, football, slalom etc.) without being able to define what a sport is (encompassing different sports and distinguishing sport from game; cf. Wittgenstein, 1953, for an interesting analysis of this issue). Vygtosky further argues that pseudo concepts are important meeting places for child and adult; with these terms (pseudo concepts), interlocutors can talk about something without the need to share concepts in a strict sense. Pseudo concepts are therefore, he suggest, important to conceptual development. Education becomes an issue of managing the complex relation between pseudo concepts and concepts. Our concepts are likely to be pseudo concepts, while proper concepts are typical of scientific work and schooled discourse. Pseudo concepts and concepts (proper) constitute similarity amidst differences, and learning to see something as an example of something more encompassing – that is, discerning a pattern – is key to early childhood science education (cf. Björklund & Pramling, 2014). As Kress, Jewitt, Ogborn, and Tsatsarelis (2001) reason about science education, more generally:

> A central issue in learning and teaching abstractions such as 'energy' (or 'force', etc.) is seeing different particular things as similar. For example, first seeing burning wood in a fire as 'like' burning petrol in an engine and then seeing both as 'like' digesting ('burning') food. (p. 127)

One recurrent observation is that learners and teachers tend to speak metaphorically when encountering what is unfamiliar or difficult to make sense of and communicate about. We have already discussed and illustrated this feature, but a few

additional points could be made. Using metaphorical or figurative terms, that is, speaking about the novel in terms of something more familiar, means to simultaneously relate and distance as integral to scientific reasoning and understanding (Kress et al., 2001). Phrased differently – and in terms of a traditional distinction in research on children's thinking and development, 'concrete' and 'abstract' – developing an understanding is not a unidirectional process from concrete to abstract. Rather, in children's sense-making practices in the form of metaphorical reasoning, they simultaneously 'concretize' (make concrete through speaking in more familiar terms) and 'abstract' (since perceiving a metaphorical relationship is an act of abstraction in being able to see some kind of similarity or analogy between diverse instances). In fact, there is an abstraction 'in-built' into cultural tools; the word 'house', for example, does not denote a particular house, but a category (Sapir, 1921; Vygotsky, 1987). Using such tools in different activities therefore also includes what Billig (1996) refers to as 'particularization', making the tool (concept) relevant for one's current concern and particular instances.

Integral to learning science is to see something as an example of something more general, to see something as an instance of a principle. Theoretical concepts constitute particular relations between situations. "One of the advantages of theoretical concepts", as contrast to more local (i.e., deictic) forms of referencing (see Chap. 11), Ivarsson (2003, p. 398) argues, "is that they, in their capacity as linguistic tools, can be used in different contexts with some meaning preserved. Or put more correctly, since they maintain a relation to earlier contexts, the meaning of concepts can more easily be recreated in new situations, a process sometimes referred to as recontextualisation (van Oers, 1998)". Appropriating cultural tools in the form of scientific concepts thus allows the learner to perceive what is observed as instances of more general and theoretically motivated phenomena or processes. Learning to see what terms are relevant and functional to speak about and perceive nature in, in itself constitute a feature of science learning. Without some communicative coordination with a teacher (or more experienced peer), the child will make sense of nature in whatever familiar terms he or she deems relevant (Fleer, 2009; see also Chap. 3). In the next chapter, we bring together these ideas and more to conclude the book. By drawing together all the themes discussed throughout the book, we present a cultural-historical model of early childhood science education.

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