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Russel Tytler, Vaughan Prain, Peter Hubber & Bruce Waldrip (Eds.): Constructing Representations to Learn in Science. Rotterdam: Sense Publishers. 2013. pp. 209.

This volum Kapitány János Sándor
e is based on a research into which many science teachers were involved. From pedagogical point of view students and teachers both made several presentations at science lessons about how the nature works, e.g. they explain the properties of matter. These can be drawings, cartoons, graphs, diagrams, videos, microscopic pictures, photos, posters, or complete presentations. When we make a representation we can also involve modern technical equipments. The authors used fourier transform infrared microscopy (FTIR) combined with synchrotron to visualize images of chemical maps for healthy cultured adenocarcinoma (AGS) cells at high spatial resolutions (between 3-5 microns) - see Figure 1.1 and the front cover of the book. We can read the following information on the back cover of the book: „The book describes a sustained inquiry in which the authors worked with primary and secondary teachers of science, on key topics identified as problematic in the research literature. Data from classroom video, teacher interviews and student artifacts to develop and validate a set of pedagogical principles and explore student learning and teacher change issues. […] The authors argue that this representational focus leads to significantly enhanced student learning, and has the effect of offering new and productive perspectives and approaches for a number of contemporary strands of thinking in science education including conceptual change, inquiry, scientific literacy, and a focus on the epistemic nature of science."

The volume has 12 chapters. In the first chapter we can read about how to make science visual and why did the authors choose the representational focus. As they mentioned several research agendas have contributed to the current strong interest in a representational focus in science education, including socio-cultural research in science education, conceptual change research, and socio-semiotic research. Their approach has been pursued predominantly with mainstream student cohorts, they argue that its foundational assumptions and practices provide leads on, and can be adapted to effective teaching and learning approaches with a wider set of cohorts (p. 7). The authors use the conceptual change research results to develop students' reasoning skills through guided work with student-generated representations. Their approach acknowledges that teachers and students need to know the form-function of the conventions in generic and discipline-specific representations. „ …representations are not simply tools for understanding some higher form of knowledge that avoids representation, what some might claim as the „gist" of concepts or models." (p. 10) They mentioned that classroom teaching and learning processes need to focus on the representational resources used to instantiate scientific concepts and practices. The representations can function in many ways. They can be reasoning and problem-solving tools, mediators and records of learning. „Representations are always partial, selective, value-laden, perspective, and offer abstracted, always constrained accounts of their referents." (p. 14)

In the second chapter we can read about the teachers' initial response to a representational focus. The authors report on a research guiding their early studies in this area, they present the results of an initial survey of 20 teachers' beliefs and practices around the role of different representations in learning science, four individual case studies of teacher responses to classroom programs that entailed a more explicit focus on the role of representations in learning science, and a framework generated from these studies to guide practice (p. 15-30). They processed a wide range of

literature in their early studies, I would highlight Peirce's (Figure 2.1., p. 17) model of the relationship between concepts and their representations. In this triadic model, distinctions are made between a concept, its representation in a sign or signifier and its referent, or the phenomena to which both concept and signifier refer. In the survey they asked 20 science teachers. (We don't have more information about the teachers or their classes.) After their findings they thought that there was a need to clarify teacher understandings of the form, function and purpose of representational work in the classroom. The four case studies were about series of science lessons in the following topics: electricity, collisions and movement, understanding of states of matter, and forces. „Analyses of the case studies suggest that teachers had shared perceptions of the challenges, benefits and conditions for effective implementation of a representation construction approach to teaching. Some of the challenges include the following points: All participant teachers recognized that this approach could be initially more time-consuming than their current practices. They also perceived significant gains in the quality and retention of student learning. This approach highlights individual students' needs and differences in understandings. This challenges teachers to develop a program to address these needs in terms of sequences of representational refinements without unnecessary duplication." (p. 25.) The teachers recognized that this representational approach made new demands on their teaching skills and knowledge. The representational approach was perceived to benefit teaching and learning, e.g. improved student knowledge building, provided a meaningful learning experience through potential linkage with everyday experiences. The authors describe an IF-SO framework, where the I and F are teacher roles (Identify key concepts and Focus on form and function), S and O are student roles (Sequence, student representation, student interest, student perceptions, Ongoing assessment, opportunity to negotiation, on-time). They felt that Roberts' „trialogue" (Figure 2.3, p. 28) provides a useful way to conceptualize how and why representations can serve student learning in science… (p. 28) then they combined Peirce's account of the three components of meaning-making with Roberts' model of pedagogy (Figure 2.4, p. 29). Their early research indicated that there was a need to develop and implement programs that aimed to focus on teacher- and student-generated multiple and multi-modal representations of science concepts. In my opinion the four case studies with different topics were not sufficient to general conclusions. As they also mentioned extended case-study research needed. „Chapter 3 to 10 describes a variety of aspects of the subsequent research program. The findings from this program form the backbone of this book." (p. 30)

The series of chapters that follows, are written about the subsequent cases, and the development of the representational approach and findings about the role and use of representations in the science learning process. Most of them include a case study with representational works e.g. students' 2D and 3D artifacts. The authors show us many examples of good practices, how to use the representational focus in science teaching and learning. They describe implications of the research findings for curriculum policy. Then they are widening the scope and scaling up the approach.

The most interesting finding is that the representational focus is very useful in the science learning process and the post-tests are always better after the using of representations. It needs the change of science teaching culture and modes, but seems very efficient. The students accept the teacher-guided representation focused science teaching, they using drawings, graph, diagrams, arrows to show the direction and magnitude of forces and making many representations, and they can improve their representations after the discussion.

Another interesting finding is the relationships between representing and modelling. The learning of curricular models, to use models approach, to revise models approach, to reconstruct

models and to learn how to construct a model de novo. „It may have seemed strange to include all these five approaches to develop the skills of representation and modelling, since only the fifth of them actually involves the de novo construction of a model. However, the realities of common practice in science education classrooms suggest that only the first approach is usually employed by teachers. Moving through the approaches, from the first to the fifth, will be an educational sequence for both students and their teachers." (p. 198)

The volume is good for triggering us to check out the representational focus in science teaching practice. Many conditions have to meet to establish a good practice. Students have to be interested in model constructing, drawing, phenomena describing and modelling. Students must be able to collaborate with their peers. Teachers must practice the arts of education. „If these conditions are met, student will be equipped, partially at least, to take an active part in the public engagement with science, for key aspects of the nature of science will have been learned." (p. 198)

In my opinion this book can be an important and valuable part of a science teacher's library.