BOOK REVIEW


This volume presents the results of a well-organized and well-coordinated effort to bring to the attention of teachers of clay science current views on teaching and assessment as promulgated by two widely circulated documents, Benchmarks for Scientific Literacy (AAAS, 1993) and the National Science Education Standards (NAS, 1996). The organizers of this workshop have attempted to integrate learning theory with the teaching of clay science. In doing so, they draw on the basic concepts of Constructivist learning theory, which has been widely adopted at the elementary and secondary education levels, and apply them to methods of clay-science instruction as practiced primarily in higher education. The result is a stimulating and provocative set of activities with plenty of fodder for those individuals seeking to improve student performance in both undergraduate and graduate-level courses.

The lead article is by Audrey Rule and is entitled, Learning theory and National Standards applied to teaching clay science. For someone not particularly concerned with clay science but generally interested in education this is a must read. Rule summarizes the central concepts of learning theory as embodied in the work of Jean Piaget (1896-1980) in which learning is seen as a state of organization of the mind. The learner moves between equilibrium and disequilibrium by interacting with the environment during the process of constructing knowledge. A model called the Learning Cycle has been developed based on Constructivist theory, and is characterized by three phases, exploration, explanation, and expansion. The central theme of the Learning Cycle is the interaction between learners and learning tasks, which is referred to as cooperative learning. The separate chapters that follow Rule’s article each presents concepts and methodologies of teaching clay science using the Learning Cycle.

Rule presents a brief but succinct overview of two national efforts to stimulate educational reform, Benchmarks for Scientific Literacy, by the American Association for the Advancement of Science, which are a series of statements about what students should know or be able to do in science, mathematics, and technology, and the National Science Educational Standards, an independent effort by the National Research Council and the National Science Teachers Association which also address what students should know and be able to do in science as well as how these accomplishments should be assessed. There is much here to rock the boat for many college-level teachers of clay science. The editors of this volume recognize that clay science as currently taught in institutions of higher education is a very diverse subject and that there is no one accepted curriculum, thus the individual projects offered in volume 11 cover a wide range of topics and themes. They are as diverse as the subject matter itself but they have in common the incorporation of the fundamental precepts of Learning Theory. Shobha Parekh and Audrey Rule use the Learning Cycle to suggest how one might teach students about colloidal chemistry and the use of colloids in the treatment of wastewater. They lead the reader through a discussion of coagulation and flocculation to the application of bentonite in wastewater treatment, and then suggest ways to use analogies to increase student understanding of these subjects. Stephen Guggenheim and Sharon Kane explore cooperative learning techniques in the teaching of clay science at both the secondary and college level. Richard Berry reviews new types of assessment tools as an outgrowth of the development of the National Science Standards and, using standards and guidelines adopted by the State of California as an example, suggests that teachers of clay science have many more assessment options available to them than the conventional formats used for so many years. He suggests that public school teachers might serve as a valuable resource for college teachers who wish to increase the effectiveness of their assessment methods.

Audrey Rule provides a very creative array of suggestions for using analogies to enhance learning in clay science and, together with Jessica Elzea Kogel, develops a group exercise using kaolin as a vehicle for learning about the commercial and industrial uses of clays. Students are provided with an extensive dataset from a hypothetical kaolin mine, available for download, from which they are to determine where to mine and what the most suitable industrial applications for those clay products might be. Ray Ferrell, Johan Forsman, and Wanda LeBlanc describe the uses of multimedia, digital images, and PowerPoint to enhance student learning in laboratory exercises. Of particular interest is their illustrated method for preparing clay slides for powder X-ray diffraction. Dennis Eberl uses his very elegant MudMaster and GALOPER programs along with Bob Reynolds’s NEWMOD algorithm to explore very sophisticated methods of introducing students to the study of illite crystallite thickness distributions and crystal growth mechanisms. Students new to clay science are able to learn by doing basic
research, and at the same time they learn to appreciate the constraints imposed by the use of theoretical models. Stephen Guggenheim presents an imaginative scheme for learning about the nature of diffraction and crystal symmetry through the use, first, of red and green laser pointers, and then X-rays. Students work in teams and learn to appreciate the fine points of superlattice spacings in mixed-layer structures as well as to identify the basic types of phyllosilicate structures. Brenda Ross and Stephen Guggenheim provide a series of student activities designed to explore the nature of ion exchange, solvation, and chemical intercalation. Paul Schroeder presents a brief background discussion and introduction to infrared spectroscopy, and then proceeds to develop a series of activities using the structural models of most common clay minerals to investigate the detections of hydroxyl groups, tetrahedral anions, and octahedral and interlayer cations. The specific example provided is smectite but the presentation is sufficiently broad that the user can develop the same activity for any clay mineral group. Finally, Jean Hemzacek Laukant uses Learning Cycle theory to show how specific physical properties of clays are related to their industrial applications. Concepts of water and oil sorption, rheology, and swelling capacity, are shown to be readily presented to and easily understood by beginning clay science students when only basic items of equipment are available. Each of these modules offers not only activities to stimulate thinking about how best to teach clay science, but they also provide excellent primers in each of the topic area in addition to URLs for downloading supplemental materials. Thus, the volume will be of interest to the general clay scientist as well as to clay science teachers at both the secondary and college levels.

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