

THIRD INTERNATIONAL  
SEMINAR ON MISCONCEPTIONS  
AND EDUCATIONAL  
STRATEGIES IN SCIENCE AND  
MATHEMATICS  
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ABSTRACTS



**The Development of Earth Concepts** Katherine Maria  
Two longitudinal case studies (beginning in January 1992) of a 5 year old boy and a 6 year old girl focused on concepts related to the shape of the earth, and the causes of day and night and the seasons. One-hour long formal sessions were held approximately every three weeks. In every session, the children were interviewed, engaged in hands-on activities, used science tradebooks, and drew or wrote in a journal. Sessions were audiotaped and transcribed. Because the researcher is the paternal grandmother of the two children, it was also possible to interview parents and teachers and collect field notes during informal family gatherings. Following Patton's (1990) guidelines for qualitative research, all sources were considered in relation to each other in analyzing the data. Factors affecting the development of misconceptions (the nature of the ideas, the child's previous understandings, the context in which ideas were presented, and the child's learning style) and sources of correct scientific ideas (e.g. TV programs, educational toys) were identified. The process by which alternative conceptions developed into correct scientific ideas is described and guidelines for instruction of young children are suggested.

**Pre-conceptions in Action in the Construction of Semantic Networks**  
Isabel G. Martins, University of London, UK

This research concerns how people use their pre-existing knowledge to make sense of scientific information presented by the media. It describes a group interview study conducted with Brazilian secondary school students, who were asked to summarize their shared understandings of a text about radioactivity by constructing a semantic network. Proposed nodes included entities and events mentioned in the text while proposed links included class/subset links, activity links (describing actions performed or suffered by elements represented in the nodes) and influence links (describing more indirect interactions). Instructions given emphasized the need for an agreement of what should be represented in the net. The group discussion which accompanied the construction of the net, revealing students' attempts to make their views explicit along the debate, were tape-recorded and aided to clarify the meaning of links and associations made. The analysis proposed measurements of network structures and used a PROLOG program written to reveal which inferences were allowed by each net making a comparison between groups possible. Results show that students' prior conceptions (as assessed in a related study) influence associations made, mostly as long causal chains with few interconnections. Possibilities of using related activities in the classroom are also discussed.

**The Structure and Use of Biological Knowledge About Mammals in Novice and Experienced Students**  
Kimberly M. Markham and Joel J. Mintzes, University of North Carolina at Wilmington  
M. Gail Jones, University of North Carolina at Chapel Hill

This study explored differences in the way novice and experienced students organize and use biological knowledge within the domain of mammals. Subjects were enrolled in a college-level, introductory biology course for nonscience majors (n=25) and an advanced course in mammalogy intended for upper-division and graduate-level students (n=25). Each subject constructed a concept map and then participated in a clinical interview, during which an exhaustive set of descriptive propositions about 20 mammals depicted in line drawings was generated. Subjects subsequently sorted the mammals into homogeneous groups. Results of concept mapping reveal that experienced students possess a substantially more extensive, complex, and integrated knowledge base characterized by significantly greater numbers of concepts, relationships, levels of hierarchy, branchings, and crosslinks. Results of clinical interviews and sorting task demonstrate that these differences are linked to the emergence of a new repertoire of implicit, superordinate concepts which orders students' understandings, the enhanced use of inferential reasoning strategies, and the development of a scientifically acceptable system of assigning class membership.

**Making the Invisible Visible: A Constructivist Approach to the Experimental Teaching of Energy Changes in Chemical Systems**  
Martins, Isabel P & Cachapuz, A - University of Aveiro, 3800 Aveiro (Portugal)

Constructivist approaches to science teaching defend that knowledge is contextual and related to the learner. This is pertinent in science experiments involving energy changes of chemical systems where the salience of phenomenological task aspects may not facilitate bridging the gap between empirical and conceptual levels of knowledge. We have reasons to believe that perceptual aspects of the task may induce students to favour one of the reactants - the "principal reactant" - as playing a more important role than the other(s) in the chemical reaction. The paper describes two studies on the alternative conception of "principal reactant" for the tasks: reaction between sodium and water (30 high school students) and combustions (open system) of magnesium and phosphorus (27 chemistry college students). The method consisted of in-depth individual interviews after demonstration of the experimental situation. Results corroborate the hypothesis: the flame was not perceived by a substantial number of students as a consequence of the chemical reaction but as a property of the sodium itself, and, in the case of the magnesium combustion the flame was transferred from the match used to start the reaction.

**Making Dissonance "Magically" Disappear: A High School Geometry Student's Limited Conceptions of Off-scale Figures**  
W. Gary Martin, University of Hawaii, HA

Figures in high school geometry are not necessarily accurate representations of the measurements and relationships given in a problem or proof. This creates dissonance which may be difficult for students to resolve, depending on their level of development. The Geometry Learning Project, a research-based curriculum development project for high school geometry, designed tasks which directly challenge students' ideas about the role of the figure. 48 students enrolled in two heterogeneously-grouped classes received instruction by Project staff based on the materials being developed; tasks focusing on the role of the figure were highlighted over the course of two months. Data collection consisted of field notes from the classes, teaching experiments with individual students, and written work including tests and journal writings. While most students reorganized their knowledge to accommodate more abstract views of geometric figures, other students found ways of circumventing the dissonance caused by off-scale figures. This paper outlines one student's resolution, in which he adopted a completely flexible view of units of measurement that led to a "magical" system in which he could accept divergent, even nonsensical, viewpoints. His conceptions are compared and contrasted to those of other students, leading to suggestions for further study and curriculum development.

**What is the nature of the understanding of the concept of 'wave-particle duality' among pre-university Physics students?**

Azam Mashhadi

Over the last fifteen years there has been considerable research interest in the student's perceptions of phenomena in such areas as energy, motion, the particulate nature of matter, electricity, and light usually at the primary and lower secondary school level. However there has been comparatively little research on students' perceptions and understanding of Quantum Physics. A review of research, and a conceptual analysis of the underlying philosophical assumptions underlying the learning and teaching of Quantum Physics is presented. An interim report is presented on a new study to elicit students' conceptions of quantum phenomena.