Mental representation of knowledge for a topic in high school chemistry [microform]

Bib ID	3282881
Format	Microform, Book
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Description	506 p.
Summary	This study investigated differences between expert and novice students for conceptual understanding and problem solving in the chemistry topic of volumetric analysis with Grades 10 and 11 Hong Kong students. Using pencil-and-paper tests together with task-based interviews, descriptions were obtained of (1) problem-solving procedures, errors, and strategies, and (2) conceptual knowledge, misconceptions and knowledge organization. An instructional intervention study with novice students to overcome observed errors and misconceptions was also carried out. For problem solving, the major findings were as follows. (1) Most errors arise from the use of erroneous mathematical formulas. (2) Both experts and students have a variety of strategies; the strategy employed depends on the familiarity of problems. Experts employ problem recognition and working forwards without search for basic problems. Experts decompose longer problems and work forwards with search to link familiar subproblem procedures. (3) Novices find most problems difficult. Means-ends analysis is first attempted. If unsuccessful, novices switch to a groping forwards strategy. Both strategies involve search. (4) Up to three kinds of problem representation are used: A keyword representation for problem identification, an abstract representation capable of qualitatively simulating a procedure (often absent with novices), and a mathematical representation. Conceptual knowledge of expert students is congruent with scientific knowledge structures in terms of accuracy, organization, and integration with problem-solving procedures. In contrast, novices have a poor comprehension of technical terms, abstract concepts are frequently linked to visual features of phenomena, and knowledge is often conflicting. Procedural knowledge is frequently independent of underlying conceptual knowledge, which precludes novices from explaining problem solutions qualitatively. Instruction involving the acquisition of conceptual knowledge together with mapping onto procedural knowledge overcame most errors and misconceptions. Understanding became more congruent with experts' understanding. Problem solving showed an increased use of strategies and representations favored by experts. Implications for instruction include a good conceptual understanding as a prerequisite for effective problem solving and proficiency with basic problems before longer problems are introduced. Teachers should include probing questions and qualitative discussion of concepts and problem solutions to expose errors and misconceptions.
Notes	(UnM)AAI8815009 Source: Dissertation Abstracts International, Volume: 49-06, Section: A, page: 1409. Thesis (Ph.D.)--Stanford University, 1988.

Reproduction	Microfiche. Ann Arbor, Mich.: University Microfilms International.
Subjects	Education, Educational Psychology. | Education, Sciences.
Other authors/contributors	Stanford University
Related records	Dissertation Abstracts International 49-06A.

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