

of incorrect classification of a problem, however, an inappropriate schema will be used instead.

This suggests that students should be taught and provided practice in recognizing and representing problem types. Lewis (1989), for example, taught students a diagramming method for representing compare problems in arithmetic. Fuson and Willis (1989) demonstrated that classroom teachers could successfully teach children to use schematic drawings to represent the structure of addition and subtraction problems. In both instances, the representational strategy benefited students in conceptualizing and solving a variety of problems.

An issue in problem-solving instruction as well is to manage cognitive load. That is, learners will be better able to construct and automate an appropriate schema or mental model for a particular class of problems when the instruction minimizes extraneous cognitive load but increases germane cognitive load. For example, goal-free problems focus learners on relevant problem states rather than the gap between the current state and the desired state. A goal-free problem asks learners to approach solving a problem by "calculating as many variables as you can" rather than "finding the value of x ," which is the ultimate solution to the problem. Other strategies for managing cognitive load in problem-solving tasks include providing worked examples and partially completed problems that learners must elaborate or finish solving (Sweller, van Merriënboer, & Paas, 1998).

Finally, because social behavior and cultural knowledge can be framed in terms of schemata (e.g., Harris, Schoen, & Lee, 1986), it makes sense to consider how schema signals cue appropriate (or inappropriate) behavior in instructional situations. One of my doctoral graduates from Taiwan, for example, found his schema for multiple-choice tests to be inappropriate for taking tests in the United States. He was accustomed to selecting more than one response on multiple-choice items and did not realize, on his first test in graduate school in the United States, that only one answer would be considered correct. Needless to say, he quickly modified that schema. Given our increasingly multicultural society and the increased demands for training in international settings, it is probably wise to keep in mind the cultural schemata learners may bring to instruction.

Making Instructional Materials Meaningful

When learners encounter instruction that makes no sense to them, it becomes an impossible task to call upon prior knowledge, because there is no way to judge what knowledge will be relevant. According to Ausubel, *potentially meaningful* information must be made understandable to learners or they will approach it in a rote fashion. He claimed that the second function of instruction was to improve the discriminability among concepts. Likewise, schema theorists looked for ways to represent the content and structure of

Learning

Observed behavior

Output:
Learned capabilities

Idea of a black box, in the operation of a computer, the major concepts of

the appropriate textual and structural text structures—content-specific text structures and (b) clearly signaling

types of signals appropriate for text structures. For example, can be useful in signaling conjunctions (e.g., consequence/effect text structures. schemata, Armbruster the "judicious use of presentation of "well-make explicit the im-

problems can also be a Sweller, Mawer, & Ward, (1987). Sweller (1989) and relatively effort- schema or in the case