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Analogical Transfer of the Control of Variables Strategy by Elementary School Children: An Instructional Method

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The key to the design of simple, unconfounded experiments is the Control of Variables Strategy (CVS) in which basic contrasts are made between experimental conditions that differ in only one factor at a time. Although the requirement to design unconfounded experiments imposes a major constraint on search in the experiment space (Klahr & Dunbar, 1988), most children (and many adults, e.g., Kuhn et al., 1995) find it difficult to master the CVS and to distinguish between valid and invalid inferences. These findings suggest that young children's difficulty in using the CVS may be due to their inability to understand the logic and to apply the strategy across domains. The present work examines whether analogy is an effective source for strategy acquisition and focuses on the processes involved in the learning and transfer of CVS in 3rd & 4th grade children.

Various analogous problems were presented sequentially to children, whose strategies in designing experiments were assessed. In the first part of the study, three isomorphic tasks were used: Spring, Slope, and Sinking problems. In each task, children were asked to design experiments to test the possible effects of each variable. By presenting tasks in three different domains, we were able to assess the extent of analogical transfer from the instructed domain to two different uninstructed domains. Children in the Training & Probe condition received explicit training instructions for the first problem and were asked systematic questions about why they designed the test they did for each trial. Children in the No Training - Probe condition were also asked questions, but no training was given. No Training - No Probe children received neither probes nor training.
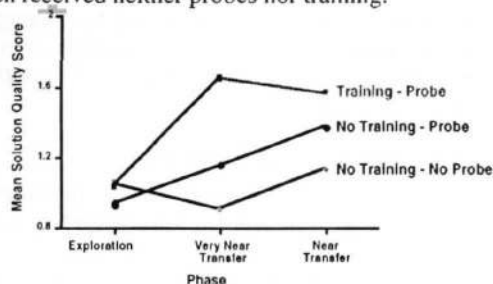

Fig. 1 Mean solution quality score by condition.

The second part of the study, taking place 7 months later, examined children's ability to transfer the strategy to remote situations. Children who participated in the first part of the study (Experimental Group) and others who did not (Control Group) were asked to solve five problems which involved evaluating whether each of a series of paired comparisons was a good test of the effect of a specific variable. The tasks differed from the earlier problems in several important dimensions, including contextual differences (different "experimenters" and different settings in which tests were administered), and task dissimilarities (different formats: hands-on vs. pencil and paper; strategy generating vs. evaluating and different content: mechanical vs. other types of problems).
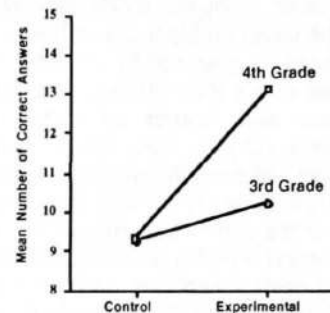

Fig. 2 Mean Number Correct on Remote Post Test

The results indicate that elementary school children's relatively poor performance using the CVS is *not* due to their inability to understand its rationale; they are capable of learning and transferring the basic strategy when designing and evaluating simple tests. Explicit training within domains, combined with probing, proved to be more effective in facilitating the acquisition of the CVS than probing alone (Fig. 1) although probes alone did have a positive effect. Elementary school children demonstrated an impressive ability to apply the learned strategies across problems. Younger children applied CVS as effectively as older children when the transfer tasks were not very remote from the original training task. However, only the older children demonstrated effective remote transfer (Fig 2). Finally, although analogy was an effective source of strategy change, the change was gradual, and even after CVS was used, children continued to use ineffective strategies for some trials. These results suggest that training over multiple trials and in diverse domains may be critical for the acquisition of CVS by facilitating the construction of a general strategy schema.

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