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ABSTRACT

This research was based on the assumption that the teaching of broadly generalizable cognitive skills should be a primary goal of education--that students can be taught to be better insight problem solvers outside of school by training in school and that they can be given the skills necessary for efficient discovery learning. The subjects were 116 students of introductory educational psychology at the University of Texas, Austin. The students were divided into small groups and exposed to an insight problem solving training procedure for approximately one hour. Following this training, each individual worked on a test booklet containing 11 insight problems for 50 minutes. Four of the groups received experimental training: dual training, visualization training, practice, or control. Comparision of adjusted scores for all groups indicated that dual training yielded the highest scores. These results lend support to the Gestalt view of insight problems, to the possibility that students can be trained to perform better on such problems, and to the suggestion that it may be necessary to combine practice and instruction to teach generalized skills. (MM)

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EFFECTS OF TRAINING ON SOLUTION OF INSIGHT PROBLEMS

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We began with the assumption that teaching of broadly generalizable cognitive skills should be a primary goal of education -- that acquisition of particular content or of content-specialized skills will be less useful to students in a changing world than will acquisition of general strategies or skills which can be used in a variety of new situations. Many educators have agreed that we should concentrate on teaching children "how to think," yet it is observed that most of what now goes on in classrooms is learning of content (Hudgins, 1973).

Research on how to teach skills or strategies is extensive, and yet it can fairly be said to have just scratched the surface. There appear to be a large number of studies directed toward teaching problem solving skills, for example, until one considers "the diversity of experimental procedures called 'problem-solving' tasks" (Davis, 1966). A variety of training procedures have been investigated in laboratory studies (instructions to verbalize, strategy instructions, hints, word-association training, etc.) but in conjunction with a variety of types of problems (insight problems, overt or covert search problems, concept formation, deductive logic problems, divergent production problems, etc.) Success of these treatments has been mixed, and many of the successful studies involved training which was highly specific to the target problem. Saugstad (1957), for example, was able to facilitate solution of Maier's pendulum problem by training component principles involved in its solution. On the other end of the generality continuum, there are several training packages, of which probably the most well known and demonstratively effective is the Productive Thinking Program by Crutchfield, Covington and their associates (Wardrop, et.al., 1969). It has been shown to facilitate problem-solving skills related to asking questions, organizing information, and drawing conclusions. With such large packages, however, it is difficult to know exactly what component treatments or features of the program are essential to facilitation or to know what theory of transfer would explain their effectiveness. Also other impressive programs for facilitating problem solving, such as those by Suchman (1962) and Taba (1966) have not yielded positive results.

In the present research, we aimed at an intermediate level of generality by focusing on a particular type of problem-solving process but attempting to achieve non-specific transfer with that process. We worked with "insight problems," which are defined here as those problems which best exemplify the Gestalt view of problem solving as perceptual re-organization, as the overcoming of false assumptions or narrow perceptions of a problem.

Although it is realized that no firm line can be drawn between insight problems and other types, they tend to be associated with reports of sudden and unexpected solutions, based on a rapid reformulation of the structure of the problem. An advantage of focusing on insight problems is that Gestalt concepts then provide a theoretical basis for the design of training procedures. Most attempts to achieve nonspecific positive transfer on insight problems have yielded negative results (Anderson and Anderson, 1963; Duncan, 1961; but see Maier, 1933). Despite these discouraging data, we thought that training of a general strategy for insight problems might still be possible because (1) previous studies had employed instruction or practice but not both -- there is indication from several sources that strategy instructions may not be effective unless combined with appropriate practice or manipulation (Saugstad, 1957; Wong, 1975); (2) the quantity of instruction or practice employed was small; or (3) training and testing procedures involved different processes (i.e., divergent vs. convergent production). In the present study, we employed a training procedure in which strategy suggestions were presented repeatedly in conjunction with attempts to solve training problems. It was hoped that the abstract point would be given concrete meaning by being given always with reference to a particular problem which the subject had been working on. Also most prior studies employed only one or a few insight problems as the criterion measure. A "test" with only a very few dichotomously scored items, all of which may be rather difficult for the subject, is probably not a very sensitive or reliable one. For the present research a test booklet was constructed in the attempt to produce more problems and a wider range of problem difficulty than is customary.

Johnson (1955) divided problem solving into three stages: preparation, production, and judgment. Essentially, the preparation stage is said to involve the process of comprehending the problem, its givens and goals and its rules for moving from givens to goals. Bourne et. al. (1971) point out that "most researchers have studied 'well defined' problems in which the subject is 'fully prepared' for the problem by the experimenter who poses it. Consequently little is known about the preparation stage" (p. 56). Yet some have claimed that formation of an appropriate and accurate initial conception of the problem is the most difficult and vital prerequisite for solving real-world problems (e.g., Langer, 1951, pp. 15-17). Though mostly neglected by researchers up to now, preparation may also be one of the stages of problem solving wherein it is most possible to change people's bad habits into good ones by training. There may be many factors affecting a person's fluency in generating hypotheses, for example, which are difficult to bring under experimental control, but perhaps people can be taught to be more careful and systematic and less narrow in their initial formulation of the problem.

A second type of instructional treatment involved instructions to use careful visualization of the processing of verbally presented problems. This treatment was attempted for several reasons. First, it appeared introspectively that careful visualization might sometimes be an aid. Some "chain-cutting problems" become easier, for example, when it is realized that cutting a single link of a chain cuts the chain "in three" rather than "in two," and it was predicted that instructions to visualize the problem carefully might help subjects "see" that this is so. Second, visual imagery has been found beneficial in a number of cognitive tasks and there is anecdotal evidence for the importance of visualization in scientific discovery and in insightful problem solving (McKeller, 1957).

Method

Subjects

Subjects were 116 students of introductory Educational Psychology at the University of Texas at Austin. They participated to fulfill a course requirement.

Design and Procedure

Subjects participated in groups ranging from 3 to 9 persons. Each was exposed to a training procedure for up to an hour; then, after a five-minute break, they were allowed to work on test problems for 50 minutes. Four groups differed as follows on training.

Dual Training -- Subjects attempted to solve each of eight insight problems in a training booklet. After they had worked on each problem they were given the "correct" solution and a lecture which emphasized both of two kinds of strategy for solving these problems. First, they were urged to work continually on reformulating their initial view of the problem to be sure they were not defining it too narrowly or making unnecessary assumptions about problem requirements. Second, the benefits of forming a very complete and detailed visual image or mental picture of the problem components were emphasized. This lecture was repeated with modified wording after each problem, using the preceding problem as an example for the abstract points made. Subjects were given a fixed amount of time to work on each problem before the answer and the accompanying lecture were given. In this and in the other conditions, diagrams accompanied answers where appropriate and hints were given for two of the problems during the time alloted to work on the problem.

Visualization Training -- All procedures and instructions for this group were identical to those of the Dual Training group, including the visualization strategy instructions, but those portions of the instructions pertaining to a problem-reformulation strategy were omitted.

Practice -- Subjects in this condition were treated like those in the two previous groups, but they were given no advice about effective strategies during the training period. This condition was included to see whether simple practice with insight problems might have an effect, i.e., whether such strategies could be learned without instructions.

Control -- Subjects in this condition were trained with a different set of problems in the attempt to control for warm-up effects. Problems in their practice booklet were arithmetical, logical, and/or search problems. This booklet was constructed in the attempt to obtain some variety in the kinds of problems presented but to avoid those having a large perceptual-reorganization component. As in other conditions, subjects were given a fixed amount of time to work on each of eight problems before solutions were presented.

Testing and Scoring

All groups worked on the same test booklet. It contained eleven insight problems which had not been used in the training booklets. We attempted to include problems which were as different from each other and from the training problems as possible with the restriction that they all were paper-and-pencil insight problems, and to include problems at several levels of difficulty. Subjects were asked to indicate all problems with which they were previously familiar by circling the number of that problem on the booklet.

Test problems were given five points if solved and zero points if not solved; thus a perfect score is 55. Test booklets were scored blind by the experimenter and a second scorer. Each subject was given a score on all items and an adjusted score which discounted circled items.

Results

Means and ranges for adjusted scores in each condition are given in Table 1.

Table 1

Group Means and Ranges

Group	Mean	Range	V+	V-
Dual Training	32.03	22-53	12.59	8.24
Visualization Training	26.21	13-41	10.24	6.66
Practice	28.55	10-43	11.72	7.86
Control	24.00	6-38	10.17	6.03

The pattern for unadjusted scores is essentially the same. On the average, subjects recognized about 0.5 of the eleven problems as familiar. Even though a one-way ANOVA for number of circled (i.e., recognized) problems did not yield a significant difference between treatments, analyses were performed on both adjusted and unadjusted scores. There was an overall difference among the four groups, $F = 5.50$, $df = 3/112$, $p < .01$, for adjusted scores; $F = 3.77$, $df = 3/112$, $p < .05$, for non-adjusted. Post-hoc comparisons with the Neuman Keuls method revealed two significant contrasts with adjusted scores: Dual Training was superior to Control ($p < .01$) and to Visualization Training ($p < .05$). With unadjusted scores, only the former contrast was significant ($p < .01$).

Discussion

One surprise in these data was the poor showing of the Visualization Training group. In the attempt to account for this finding, we speculated that visualization might be helpful with problems such as chain-cutting problems which require attention to detail, but with other problems visualization might actually hinder by making it more difficult to question false assumptions. Consider, for example, the problem:

> Design a clock which has no moving parts on its face, nor with any kind of feature which is visibly changing during normal use. Describe it very briefly.

The "correct" answer was to describe some form of auditory clock. Perhaps the assumption to be overcome is that clocks must convey information visually. If so, visualization instructions might make this assumption more difficult to resist. Visual imagery may also be distracting whenever a solution requires close attention to the wording of the problem. With this view in mind, several problems were picked out where visualization seemed intuitively to be most likely to help (called V+ in Table 1) and several where it seemed most likely to hinder (called V- in Table 1). This post-hoc analysis was not successful; it can be seen that relative performance of the Visualization group is pretty uniform over problem types. Perhaps there is something to be said for the view of Ehrenzweig (1976) who stated that "precise visualization or worse still a straining of one's attention to see crystal-clearness where there is in fact none, will only produce wrong or unusable results," and who quoted the mathematician Hademand as making the same point about creative mathematical problem solving.

Results of the study are more encouraging for the other strategy instruction employed. Several explanations of the superiority of the Dual Training group to the Control group can be offered. One is that performance of the Control group reflects, as intended, only warm-up effects and that the combination of training events employed in the Dual Training condition is necessary to surpass that baseline. It is also possible that strategies learned by the Control group produced negative transfer which contributed to the difference. To help choose between these possibilities, a follow-up study has been performed using two new control groups, and it seems to indicate that assumption-questioning instructions can have a positive effect.

Tentatively, then, it will be concluded that these results lend support to the Gestalt view of insight problems, to the possibility that students can be trained to perform better on such problems, and to the suggestion that it may be necessary to combine practice and instruction to teach such generalized skills. Such training might be effective because it overcomes what Asher (1963) calls the "illusion of the unsolvable problem." Or perhaps students have been influenced to devote more of their time to the initial preparation stage of problem solving and have profited from doing so.

This research has not demonstrated that students can be taught to be better insight-problem solvers outside of school by training in school or that they can be given the skills necessary for efficient discovery learning. The differences obtained were small and there was no evidence that they would be retained over time or over a larger change in situational context (with behavioral or social problems, for example). Our data offer some encouragement; perhaps one can conclude that generalized training effects are possible, but they are surely not easy to achieve.

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