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ABSTRACT

This study addressed the problem of promoting generalization of knowledge in people with mental handicaps, by presenting an approach based on the idea that certain cognitive representations of strategies and related concepts are common to solving a wide variety of problems. The surface context of these problems may vary considerably, but all will require the use of a common mental representation. The example used in the study was numerical evaluation, which is required in a wide variety of contexts including time telling, money skills, science, social numeric tasks, and graphic copying. Educable and trainable teen-aged students (N=13) were taught numeric evaluation skills using a guided discovery approach and then were found to be able to use their knowledge in a wide variety of situations. Numerical evaluation questions and generalization questions are appended. Includes eight references. (Author/DB)

Common Mental Representation:

A Cognitive Guide to Promoting Wide Generalization

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One of the most pervasive educational issues is how to teach students to apply their knowledge in new situations, i.e., how to generalize. This is an issue in all of education but particularly with mentally handicapped learners. Mentally handicapped learners are typically described as being bound (or welded) to specific situations theoretically due to a passivity (Brown & Campione, 1981) or inflexibility (Kreitler, Zigler, & Kreitler, 1990) in their learning approach. The difficulty that instructional designers face is to define what knowledge is necessary in order that students will be able to generalize and to specify the circumstances where such knowledge can be applied.

Existing behavioral approaches to teaching generalization are well developed with respect to techniques for promoting the application of knowledge in new situations (see Horner, Dunlop, & Kuegel, 1988). However, there are two main problems with this approach: (1) The focus is often on specific skills. The limitation of this is that there are many specific skills which handicapped learners must acquire and training each one separately would be too cumbersome; (2) What knowledge can be generalized (the notion of stimulus class) has never been well defined (Brown, 1990) so it is difficult for an instructional designer to know what situations existing knowledge can be generalized.

A recent alternative approach can be found in the teaching of general metacognitive strategies. The rationale of this approach is that general cognitive strategies can be taught which can then be applied across a wide range of situations. This would enable the student to be more active in the learning situation and reduce the amount of dependence on a direct instructor. The consensus, however, is that generalization effects have been limited (Borkowski & Kurtz, 1987). Successful programs have been particularly difficult to devise for younger children and for those of a lower mental level because of the reliance during training on verbal and metacognitive skills which these learners have not developed (Borkowski & Kurtz, 1987).

In the present study, an approach which focuses on cognitive representations is presented to explain and demonstrate how wide generalization can be achieved by handicapped learners. In this approach, the focus is not on the external stimulus per se or the cognitive strategy in itself, but the learners understanding (cognitive representation) of the cognitive class of problems that can be solved. The cognitive representation for problem solving would include both strategic and related conceptual features. The conceptual features include elements of when and why to apply strategies and the relationship of those representations with other representations. The generality of this class (that is, the ability of students use of knowledge of the class in new situations), will depend on the learner's ability to understand and view the common cognitive features across problem situations (this theory was initially presented by Case, in press).

In the present investigation, the cognitive class was numeric evaluation. The components to this class are number knowledge (verbal labelling and sequencing, one-to-one correspondence, cardinality, set discrimination) and knowledge of evaluation, e.g., whether some set of objects or events is more or less than another. This specific cognitive class has a wide range of application. Number knowledge can be used to evaluate whether some event is before or after another, whether one weight is heavier than another, whether a certain amount is worth more than another, whether a set of lines is equivalent to another, or whether one time is longer than another. The mental representation of number knowledge and its use for evaluation is common to a wide variety of specific situations which vary in surface structure (or stimulus features).

The empirical question which emanates from this theoretical notion is: Can students who are taught numerical evaluation strategies and concepts apply their knowledge across the wide range of tasks, as outlined above? If they can, it would be especially useful for mentally handicapped students who are reported to be poor in their generalization abilities.

Present Study

Thirteen teenaged mentally handicapped students were selected. Seven had been previously classified as Educable Mentally Retarded and six as Trainable Mentally Retarded by their school board. They ranged in age from 17 years 2 months to 19 years 10 months. They were pretested and posttested on numeric evaluation questions (see Appendix A) and questions which assessed generalization of numeric evaluation in the specific areas of time telling, money skills, science reasoning (Piaget's balance beam task), social numeric reasoning, and a graphic copying task (see Appendix B). Statistical analysis was done on the change scores using the McNemar non-parametric test for related samples. Students were given instruction in numeric evaluation. This was done in small groups (4-5 students per group) for 10 sessions, each session lasting approximately 20 minutes. Since their counting skills and concepts were adequate, instruction focused on making evaluations based on numbers, which was found to be lacking.

There were a number of sets of training situations given within a developmentally based, guided discovery approach (Case, 1978). In the first set, students were presented with contexts which were designed to overcome their initial spontaneous strategy of merely looking at two objects and then judging without using counting. For example, they were shown two sets of necklaces which were rolled up and they had to determine which was longer. Once they had made a choice, they were encouraged to justify their responses and then concrete feedback was given by unravelling the necklaces and looking at the lengths. This was done a number of times with various necklaces and other objects such as connected paper clips. When students erred, they were encouraged to explain how the correct answer could be derived. The notions of one-to-one correspondence of items between each set and cardinal numeric comparison were discussed.

Students were then instructed in other situations where comparing two sets was necessary. For example, they were given a scenario where a group of children rode their bikes to the store and then when they came out there were either less or more bikes corresponding to the number of children. Students had to make a numeric evaluation of the situation in order to determine what might have happened (e.g., when there was one less bike, someone's might have been stolen because it wasn't locked up).

Finally, students were given a set of evaluation questions where the only feedback was from the instructor. For example, a situation would be presented where a picture of two hives of bees was shown and students had to evaluate which was going to make the most honey. They could only determine this accurately if they counted the number of bees on each side and made a numerical comparison. Variations of this task were done, such as comparing two sets of armies to see who would likely win. There was no classroom instruction during this time in any of the situations which were used for assessing generalization.

Results

The students made a significant improvement on the test items related directly to training as measured in Appendix A questions. On the pretest 62% of the students passed the questions and on the posttest 92% passed. Since the items were similar, but not the same as the training tasks, they are an indicator that students were able to make near generalizations. It was also hypothesized that if students were able to make improvements here, then they would be able to use this central, common knowledge to a wide range of situations. This was confirmed by the wide generalization tasks. Students were able to solve problems which relied on their knowledge of numeric evaluation in domains of time telling, money skills, social numeric problems, the balance beam problem, and the graphic copying task. The results are given in Table 1. Note that in the two tests that were nonsignificant, students were already performing well, leaving little room for a statistical improvement.

Summary and Conclusions

One of the most critical and pervasive issues in remedial education is how to promote active learning in students so that they can generalize their knowledge to new situations. Although educational prescriptions exist for promoting generalization, major difficulties exist in defining the knowledge necessary for generalization and specifying the situations where generalization can be expected.

In the present study, the theoretical construct of common mental representations was used as a device to analyze knowledge that would be needed for wide generalization. Unlike a general cognitive strategies approach, this notion deals with specific knowledge representations. However, it isolates those representations with the widest common applications. It also differs from behavioral theories in that it does not focus on stimulus (external) features. It takes into consideration the learner's cognitive understandings which can transcend stimulus features. In the present case this allowed for the prediction, which was verified, that students could generalize their knowledge of numeric evaluation to a wide variety of situations. This is significant when viewed in the light of existing research which has found that obtaining any form of wide generalization is very difficult to achieve.

The results here are promising, but must be considered preliminary from both empirical and theoretical perspectives. In the present study, there was no control group to demonstrate that students who did not receive training would have difficulty solving the wide range of tasks presented. Although this was the case here, it should be mentioned that in another study (Sandieson, 1988) young normal IQ students were taught to generalize as was done in the present study. In this study a control group (training in number skills but not evaluation concepts) was used and this group was unable to solve the wide range of generalization problems.

From a theoretical point of view, what needs to be established is how common mental representations can exist at various levels of problem complexity and across various domains, such as social, linguistic, and affect. To establish this, the cognitive structures (e.g., scripts, semantic networks), used by researchers in these areas, will need to be employed with a perspective on general and specific information. Then an instructional paradigm such as the one employed here might be used to promote knowledge acquisition and ultimately wide generalization.

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Table 1

Generalization Table

Number of Students Passing

	Money $7vs$6	Money $5vs$1 +$1	Time 7vs9 Minutes	Time Early/ Late	Balance Beam	Social-Numeric	Graphic Repro-duction
Pretest	7	7	3	6	0	3	4
Posttest	12*	11	13**	10	8**	12**	13**

* $p < .05$
** $p < .01$

Appendix A

Numerical Evaluation Questions

1. "There are nine bingo chips in this container (student can't see inside), and there are four in this one. Which one has more or is the biggest amount?" Students are asked to explain why they chose a particular amount.

2. Same questioning format as above only the numbers are 7 and 8.

3. Same format only numbers are 9 and 6.

4. Same format only numbers are 8 and 5.

Appendix B

Generalization Questions

Money Skills Problems:

1. "Here is a pile of dollars (seven arranged so that some are overlapping each other). Here is another pile (six in the same type of pile). Which pile has more dollars?"

2. "Here is a bill ($5.00). How many dollars do you think this is worth? (If the student does not answer correctly, point to the five and say five). Here is another bill ($1.00). How many dollars do you think this is worth? (Use the same prompting as above, if necessary)." Have two piles - one with a $5.00 bill and one with two $1.00 bills. "Here are two piles. Which do you think is worth more money?"

Time Telling Problems:

1. "Which is longer - seven minutes or nine minutes?"

2. (Demonstrate all times on the clock). "Suppose every day you wake up from an afternoon nap, say at 2:00 o'clock. Then you go outside and play until 3:00. Then you have your supper at 5:00. Suppose today it's 4:00 - have you had your supper yet?"

Balance Beam Task:

1. Show a balance beam and explain that it is like a teeter-totter. It goes up and down. If one side is heavier, that side will go down. "There are eight weights on this side, and nine on this side, which side will go down?"

Social-Numeric Task:

1. "This is a picture of David. This is a picture of Cathy. They lived in different cities. Today each one of them had a birthday party. Cathy and David both wanted bingo chips for their birthday present. (Evaluator places next to the picture of David and Cathy the number of bingo chips they received for their birthday present. David receives this many (8 arranged in a scattered pile) and Cathy receives this many (7 in a scattered pile). Who do you think was happier at their birthday party?"

Graphic Reproduction Task:

1. Students were shown a drawing of eight lines and asked to make a drawing which was exactly the same as the model.

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