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THE EFFECT OF TEACHING SIXTH GRADERS WITH LEARNING DIFFICULTIES A STRATEGY FOR SOLVING VERBAL MATH PROBLEMS

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The University of Kansas Institute for Research in Learning Disabilities is supported by a contract (#300-77-0494) with the Bureau of Education for the Handicapped, Department of Health, Education, and Welfare, U. S. Office of Education, through Title VI-G of Public Law 91-230. The University of Kansas Institute, a joint research effort involving the Department of Special Education and the Bureau of Child Research, has specified the learning disabled adolescent and young adult as the target population. The major responsibility of the Institute is to develop effective means of identifying learning disabled populations at the secondary level and to construct interventions that will have an effect upon school performance and life adjustment. Many areas of research have been designed to study the problems of LD adolescents and young adults in both school and non-school settings (e.g., employment, juvenile justice, military, etc.)

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Cooperating Agencies

Were it not for the cooperation of many agencies in the public and private sector, the research efforts of The University of Kansas Institute for Research in Learning Disabilities could not be conducted. The Institute has maintained an on-going dialogue with participating school districts and agencies to give focus to the research questions and issues that we address as an Institute. We see this dialogue as a means of reducing the gap between research and practice. This communication also allows us to design procedures that: (a) protect the LD adolescent or young adult, (b) disrupt the on-going program as little as possible, and (c) provide appropriate research data.

The majority of our research to this time has been conducted in public school settings in both Kansas and Missouri. School districts in Kansas which are participating in various studies include: United School District (USD) 384, Blue Valley; USD 500, Kansas City; USD 469, Lansing; USD 497, Lawrence; USD 453, Leavenworth; USD 233, Olathe; USD 305, Salina; USD 450, Shawnee Heights; USD 512, Shawnee Mission, USD 464, Tonganoxie; USD 202, Turner; and USD 501, Topeka. Studies are also being conducted in Center School District and the New School for Human Education, Kansas City, Missouri; the School District of St. Joseph, St. Joseph, Missouri; Delta County, Colorado School District; Montrose County, Colorado School District; Elkhart Community Schools, Elkhart, Indiana; and Beaverton School District, Beaverton, Oregon. Many Child Service Demonstration Centers throughout the country have also contributed to our efforts.

Agencies currently participating in research in the juvenile justice system are the Overland Park, Kansas Youth Diversion Project and the Douglas, Johnson, and Leavenworth County, Kansas Juvenile Courts. Other agencies have participated in out-of-school studies--Achievement Place and Penn House of Lawrence, Kansas, Kansas State Industrial Reformatory, Hutchinson, Kansas; the U.S. Military; and the Job Corps. Numerous employers in the public and private sector have also aided us with studies in employment.

While the agencies mentioned above allowed us to contact individuals and supported our efforts, the cooperation of those individuals--LD adolescents and young adults; parents; professionals in education, the criminal justice system, the business community, and the military--have provided the valuable data for our research. This information will assist us in our research endeavors that have the potential of yielding greatest payoff for interventions with the LD adolescent and young adult.

Abstract

This study attempted to address and answer the problem of whether sixth grade students with learning disabilities could learn a verbal problem-solving strategy and apply it effectively. It was proposed that sixth graders with learning difficulties could benefit from systematic teaching of a verbal problem-solving strategy.

Using a multiple-baseline design, the subjects were taught a seven step verbal problem-solving strategy. Daily measures of percent correct on eight third grade level, one-step mathematics word problems were graphed showing progress. A posttest of eight similar problems taken from a class text was given to show carry over of the strategy from controlled materials.

The results indicated an increase in percent correct on eight mathematics word problems for each subject following intervention. Baseline probes never overlapped with treatment probes indicating that generalization is possible to other students in the population studied. It is anticipated that this will be the beginning of an effective teaching-learning methodology that could be expanded to include different strategies at different grade levels.

Research Report No. 15:	Health and Medical Factors
Research Report No. 16:	Behavioral and Emotional Status from the Perspective of Parents and Teachers
Research Report No. 17:	The Relationship of Family Factors to the Condition of Learning Disabilities
Research Report No. 18:	Social Status, Peer Relationship, Activities In and Out of School, and Time Use
Research Report No. 19:	Support Services
Research Report No. 20:	Classification of Learning Disabled and Low-Achieving Adolescents

THE EFFECT OF TEACHING SIXTH GRADERS WITH LEARNING DIFFICULTIES A STRATEGY FOR SOLVING VERBAL MATH PROBLEMS

Teachers and researchers in the field of mathematics have historically been concerned about the difficulties encountered by many students in solving verbal math problems. Difficulties in this area are seen as particularly critical since an ability to generalize mathematical skills to problem solving in real-life situations is a major instructional goal within mathematics education. People use mathematical skills every day in balancing checkbooks, counting change, buying goods, and dealing with other financial settings. If the student lacks an efficient, reliable means of solving verbal problems, he/she will probably find it difficult to solve real-life problem situations. For example, students who scan problems to get numbers without reading to determine what the problem asks for are not persistent in their search for information and use a trial and error method which inevitably leads to an incorrect answer (Klausmeier & Loughlin, 1961).

In spite of Lester's (1977) conclusion that "our knowledge of problem solving is more of a hodge podge of information than a cohesive body of knowledge" (p. 12), the area of problem solving has been studied, primarily by researchers in the fields of psychology, mathematics education, and special education. Among the psychological research related to problem solving, studies by Brownell (1942), Maier (1970), and Simon (1976) offer helpful suggestions for classroom teaching. For example, the key elements in Brownell's model for the development of problem-solving abilities stressed the importance of practice, learner awareness of inefficient as well as correct techniques, use of different techniques applied to the same problem, and exposure to errors during the learning process.

Based on the work by individuals like Brownell and Maier, mathematics educators began to develop methods, strategies, and approaches to problem solving for normal and handicapped students. Faulk and Landry (1961) and Unkel (1961) studied the effect of a particular acquisition method on the math problem solving of various groups of learners. While Unkel suggested that the solution to the problem may be found through a group effort, Hollander (1974) and Suydam and Weaver (1977) developed more structured methodologies to verbal problem solving.

Within the field of special education several researchers (Brueckner, 1955; Klausmeier, 1961) have studied the problem-solving behaviors of exceptional children arriving at results agreeing with psychological research in the areas of verbalization and strategies. Jacobson (1969) outlined a guide to problem solving specifically designed for special educators.

The recent literature on problem solving and strategies have built upon previous studies and theories, but provide more specific methodology. Meichenbaum (1975), Bornstein (1976), Dansereau (1979), and others emphasized the importance of self-instructional models in dealing with both academic and behavior problems. Kramer (1966, 1970) suggested a series of sequential steps for mathematics problem solving which was later adapted to a self-instructional model (Meichenbaum, 1975) and was sequentially arranged for use in a learning strategies model (Alley, & Deshler, 1979).

The learning strategies model (Alley & Deshler, 1979) makes use of self-instructional models in acquisition steps. The task is broken into specific rules or steps to be learned and applied by the student. Specifically, as in this study, the model can be applied to problem solving in mathematics. The student is first made aware of his/her current inefficient learning habit so that comparisons and references can be made to the

new method. Given a set of organized, efficient steps to use as a strategy the student can learn them by verbalization. Practice follows, with varied problems, situations, and settings to establish a firm understanding of the new strategy. Thus, the verbal problem solving steps (adapted from Kramer, 1970) can influence the nature of the student's learning habit and performance.

This study attempted to address and answer the problem of whether sixth-grade learning disabled students could learn a verbal problem-solving strategy and apply it effectively. It was proposed that these students could benefit from a learning strategies model (Alley & Deshler, 1979) making use of self-instructional models.

Methodology

Subjects

Three learning disabled sixth graders exhibiting particular problems were chosen for the study. Math deficiencies were determined based on teacher recommendation and PIAT or Key Math scores of two years below grade level in math skills. The students had low-average to average IQ as measured by the WISC-R and showed discrepancies of two to two-and-one-half years between expected and actual academic performance (see Table 1). It was assumed that the sample academically represented typical students receiving resource room help for the specified learning difficulties.

Insert Table 1 about here

Table 1

Subjects

Student	Sex	CA	Grade	IQ*			Math Grade Level Achievement
				VS	PS	FS	
I	M	12	6.7	low ave.	ave.	low ave.	3.2 (PIAT)
II	F	12	6.7	low ave.	ave.	below ave.	4.3 (Key Math)
III	M	12	6.7	low ave.	high ave.	ave.	4.6 (PIAT)

*Numerical IQ scores were not available

ave. = average range

Procedures

During the intervention stage the following five general steps were completed:

1. Make student aware of current learning habit
2. Explain alternative strategy (show contrast)
3. Learn strategy (verbalize)
4. Apply strategy to controlled materials
5. Posttest: apply strategy to classroom materials

The verbal problem-solving strategy used (see Table 2) represents an adaptation of the Alley-Deshler (1979) model designed especially for

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Insert Table 2 about here

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intermediate-grade LD students. Ten days of original baseline were taken whereupon the intervention stage was initiated according to the steps previously listed. After observing and making a student aware of his/her incorrect approach to a problem, and after demonstrating an alternate strategy, the investigator read each step of the verbal problem solving strategy (which was simultaneously listed on the chalkboard) to the student explaining the function of each step. On succeeding days a fading system, relating to instructor prompting was employed until the students were able to independently verbalize the strategy each day before attempting to solve any of the math problems. Eventually, verbalizing the seven steps became a group task wherein the students took turns naming the steps. Verbalizing the strategy without assistance was considered to be maximizing the probability of the student using this approach in solving the problem.

Table 2

Suggested Steps in Verbal Problem Solving*

	Example Problem
	Kathy had 69¢. She spent 17¢ on candy. How much money does she have left?
I. Read the Problem: preview	
1. Find unknown words	none
2. Find "cue words," e.g., "total", "in all", . . .	"How much . . . have left?
II. Reread the Problem: information processing	
1. Identify what is given	
a. Is renaming needed?	
i. unit changes	none
ii. categorization	none
b. Is there any information given that you don't need?	none
2. Decide what is asked for	
a. What process is needed? (comparing, combining . . .)	separating
b. What unit or category is asked for? (minutes, fruit, . .)	cents
III. Use Objects to Show the Problem	
1. "See" the problem	
2. Decide what operation to use	separating; subtraction
IV. Write the Problem	69¢ - 17¢ = _____
V. Work the Problem	69¢ - 17¢ = 52¢
VI. Check Your Answer	repeat steps I - V
VII. Show Your Answer	Kathy has 52¢ left.

*Adapted from Kramer, Project Math, 1970.
Modified 3-27-79

Finally, a posttest consisting of word problems from a classroom text was administered after the new strategy had been applied to controlled materials resulting in a maintained increase of correct responses.

Data Analysis

Daily data were plotted to determine rate of change for each subject and to enable a comparison of the performance of all three students. The followup test was conducted to compare the mode, median, and mean before and after intervention within and between students. Furthermore, estimates of the standard error of the mean in the sample as well as time effectiveness of the strategy were computed. Case study records were also maintained on the kinds of errors made and other relevant observations for the purpose of determining the need for future modifications of the strategy.

Materials

Eight written math word problems selected from a third-grade math textbook (students' instructional reading level) were used to measure the dependent variable, i.e., the percent correct of word problems. The problems consisted of two addition, two subtraction, two multiplication, and two division problems -- all one-step problems. All types of problems were randomly distributed on the page to control for memorization of the order of presentation. The posttest consisted of eight similarly selected problems from the students' regular classroom mathematics text, i.e., grade five.

Results and Discussion

The results of this investigation of the effectiveness of a learning strategies technique using self-instructional models in enabling learning disabled sixth graders to learn and apply a verbal math problem-solving

strategy indicated an increase in percentage correct for each student after intervention (see Figure 1).

Insert Figure 1 about here

Each student achieved a gain in average percent correct after being taught the learning strategies (see Table 3).

Table 3

Student Averages Before & After Intervention

	Student 1		Student 2		Student 3	
	Before	After	Before	After	Before	After
Mean %	16.4%	98.8%	18.2%	98.8%	27.7%	97.2%
Mode %	18.8% & 12.5%	100%	18.8%	100%	31.3%	100%
Median %	15.7%	100%	18.8%	100%	25%	100%

The greatest gain among the three subjects was found in Student 1's mean performance before intervention (16.4%) to after intervention (98.8%), a gain of 82.4%. Students 2 and 3 made gains of 80.6% and 69.5%, respectively, following the treatment program. The overall averages across the three subjects are presented in Table 4 showing an average gain of 75.4% correct in solving eight math word problems using controlled materials.

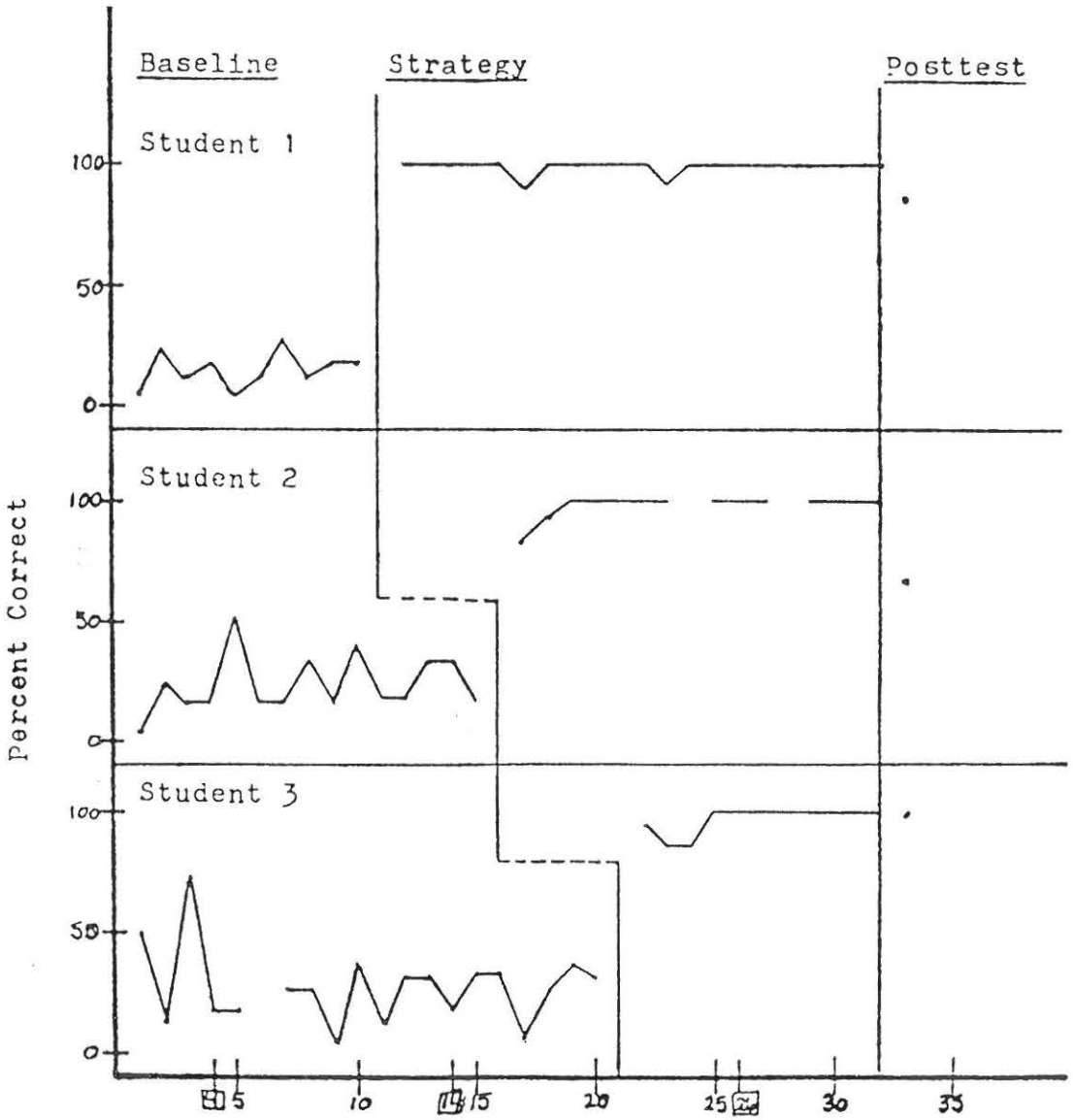

Figure 1. Subjects' daily percent correct on 8 math word problems.

Table 4

Averages Across Students Before & After

Learning the Problem-Solving Strategy

	Before	After
Mean %	23.0%	98.4%
Mode %	18.8%	100.0%
Median %	18.8%	100.0%

When considering the large increase in percentage correct as a result of the intervention phase, the short time span within which these increases took place becomes an important factor. As illustrated in Table 5, each student exhibited a significant daily improvement with the average learning rate of the three subjects being 43% per day before reaching 100%. On an average, students required 2.6 days to demonstrate the new strategy as applied to the eight presented math problems.

Table 5

Average Rate of Learning

(% per day)

Student	Mean % Before	N*	Learning Rate
1	16.4%	1 day	83.6%/day
2	18.2%	3 days	27.3%/day
3	27.7%	4 days	18.0%/day
Total Averages	23.0%	2.6 days	43.0%/day

*N = number of days required to reach 100% correct

Case study observations relating to student comments on the learning strategy made during this investigation indicated that students experienced little difficulty in recalling the problem-solving steps, a finding which is in accordance with Meichenbaum's (1975) statements on self-instructional models. The method of making the students aware of their old ineffectual learning habit made the students more receptive to the new strategy. Coupled with student motivation, practice, and demonstration, this awareness of an ineffectual strategy appears to be an essential element in the success of the learning strategies model.

Summary

A review of the findings of the present study reveals that the learning strategy significantly affected the students' performances in solving eight math word problems as illustrated in the increase in percent correct from an average of 18% (baseline) to 97% (after intervention). The results agree with the theoretical base of the learning strategies model (Alley & Deshler, 1979), psychological studies in problem solving (Brownell, 1942; Maier, 1970; Simon, 1976), and theories of self-instructional models (Meichenbaum, 1975). Both the modified verbal problem-solving steps (Kramer, 1970) and the acquisition steps (Alley & Deshler, 1979) seemed to contribute to the success of the study.

While the learning strategies model has been used successfully with learning disabled adolescents in the past, results of the present study indicate that such strategies may be extended to sith graders, thus providing these students with sound learning strategies before they move into junior and senior high school with the concurrent increase in academic and social demands.

While the results of this study are encouraging, questions relating to transferability of skills to new situations as well as generalizability of findings to a broader population of learners need to be explored in future investigations.

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