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AUTHOR Barrish, Bernard

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ABSTRACT

This study was undertaken to determine the relationships among levels of divergent thinking and the differential effectiveness of inductive and deductive teaching strategies. It was hypothesized that high divergent subjects would score higher under the inductive-guided discovery strategy than under the deductive-reception strategy while the opposite would be true for the low divergent students. Subjects were 128 fourth, fifth and sixth grade subjects who had scored over 100 on a Lorge-Thorndike IQ test. Verbal Form A of the Torrance Tests of Creative Thinking was used to determine the levels of children's creative thinking. The pupils were assigned to either an inductive-guided discovery instructional strategy group or a deductive-reception instructional strategy group. Initial subject matter was familiar. A test of acquisition was given after a 20-day experimental period; a test of retention 20 days after the first test. Data was analyzed by multiple regression analysis used and analysis of covariance was computed to test the differences by treatment in the criterion tests. Conclusions were: (1) levels of divergent production as measured by the verbal test of Torrance were not related to children's initial learning or retention of mathematical generalizations no matter what the style of presentation; and (2) for the learning of low cognitive mathematical material, the deductive-reception strategy proved superior to the inductive-guided discovery strategy. Statistical tables are included. (Author/AJ)

INDUCTIVE VERSUS DEDUCTIVE TEACHING STRATEGIES WITH HIGH AND LOW DIVERGENT THINKERS

Bernard Barrish, Ed. D., Associate Professor
California State College, Hayward

This study was undertaken to determine the relationships among levels of divergent thinking and the differential effectiveness of inductive and deductive teaching strategies.

Hypothesis

It was hypothesized that there would be an interaction in that high divergent subjects would score higher under the inductive-guided discovery strategy than under the deductive-reception strategy while the opposite would be true for the low divergent students.

Experimental Groups

All of the children in the fifth and sixth grades and all the fourth graders with I.Q. scores over 100 on a Lorge-Thorndike I.Q. test in a Pacifica, California, school were included. In all, 128 students were utilized in the experiment. The Verbal Form A of the Torrance Tests of Creative Thinking was the instrument employed in determining the levels of the creative thinking. Responses from all seven sub-tests were scored for combined scores of fluency, flexibility, and originality.

Treatment

The pupils were assigned to either an inductive-guided discovery instructional strategy group or a deductive-reception instructional strategy group. Two classes of 32 children were assigned to each strategy for a 50-minute mathematics period during 20 school days. After ten school days, the teachers changed groups and instructional strategies. Thus, all of the children were exposed to two of the four teachers. Each treatment group as pooled was taught by all of the teachers. (See Diagram A)

The Teaching Materials

Subject matter consisted of topics taken from text and other materials ordinarily utilized at sixth, seventh, eighth, and ninth grade levels, so that they were quite unfamiliar to the pupils. The first topics taught were chosen so that the foundation concepts, i.e., those which underlie the new concept development in the experiment would be familiar to the children. The remaining topics developed those taught earlier in the experiment.

The Instructional Strategies

Effort was maintained to foster equal teacher behavior except as a direct required consequence of the strategy taught. Teachers were to remian pleasant, supportive, and to encourage pupil participation in both strategies. Both strategies included concrete manipulation and identical drill content.

The deductive-reception strategy represented a simple straightforward example of traditional teaching done by:

1. Presentation of the generalization or principle.
2. Reinforcement by:
   a. Showing examples
   b. Answering pupils questions
   c. Clarifying and reiterating the principle.
3. Concrete manipulation where feasible.
4. Asking questions for feedback from pupils.
5. Drill

The inductive-guided discovery strategy had discovery of the principles or generalization as its goal. The order of instruction was as follows:

1. Concrete manipulations where feasible.
2. Presentation of facts to be related.
3. Eliciting discovery through discussion by:
   a. Giving specific examples
   b. Answering questions of students
   c. Asking leading questions if a. and b. did not lead to discovery
4. Restating the discovered generalization.
5. Drill period.

The Criterion Tests

A test of acquisition was administered after the 20 day experimental period. Of the 35 problems, ten called for "high cognitive" responses involving some degree of transfer, application of the given principle in novel situations, or more complicated independent thinking. The remaining 25 problems were termed "low cognitive". They required recall and manipulation of algorithms or application of the principle in examples similar to those used in the lessons. The scoring of the problemswas weighted according to the proportionate length of time spent in instruction.

The test of retention was administered 20 school days after the test of acquisition. The order of the questions was altered as were the numerical equivalents without affecting the difficulty of mathematical operations or language. In all other respects the tests were identical.

The Statistical Analysis

Multiple Regression Analysis was the prime statistical procedure employed. Multiple regression slopes were computed to evaluate interrelationships of grade, I.Q., Total Divergent Production Score, and fluency, flexibility, and originality as sub-scores by instructional strategies according to scores on the criterion tests. F tests were used to determine the statistical significance of the individual regression slopes for each treatment. The level of significance for denying the null hypothesis was specified as $p < .05$ on a two-tailed test.

After the initial analysis, upon inspection of the adjusted group means, an analysis of covariance with I.Q. as the covariate was computed to test the differences by treatment in the criterion tests.

The Findings

Multiple Regression Analysis

All correlations between the divergent production scores and the tests of acquisition, retention, the high cognitive, and the low cognitive sub-scores were not significant, are very low level and indicate that something other than the independent variables are responsible for results on the dependent variables. The correlations of I.Q. and Grade Level show statistical significance in all cases but one. The findings of I.Q. and grade level significance are, of course, not novel. Their value is merely to help establish the validity of the other analyses.

Analysis of Covariance

For the analysis of covariance a very different picture appears. Significant treatment effects at the .01 level favoring the deductive group were found on the total scores of the test of acquisition and the low cognitive sub-tests, but not on the High Cognitive sub-tests. For the test of retention, the differences between the adjusted group means for the two treatment groups were not significant in the total test scores nor the high cognitive sub-test scores, but they remained significant at the .05 level favoring the deductive group for the low cognitive sub-scores. The differences between the adjusted group means for the two treatment groups apparently are manifestations of the differences in treatment, not I.Q. as has been shown in the multiple regression analysis above.

Major Conclusions

(1) Levels of divergent production as measured by the verbal test of Torrance of these middle grade children were not related to their initial learning or retention of mathematical generalizations whether presented an inductive-guided discovery strategy or a deductive-reception strategy.

(2) For the learning of low cognitive mathematical material, the deductive-reception strategy proved superior to the inductive-guided discovery strategy.

A few cautions and points at issue might be noted in generalizing the present results. For example:

a. Both the children and the teachers expressed frustration at not being permitted to vary the teaching procedure.

b. Although the instruction was carried on over a relatively long period of time, there may be some question as to whether the learning strategies of the past, based primarily on deductive teaching, can be overcome.

c. Other age grou of children and other subject matter may lend themselves to alternate methods of teaching.

d. The Torrance Tests of Creativity is still a somewhat experimental instrument and therefore may not have been adequate as a base for forming the groups.

e. Since high cognitive material was acquired equivalently by either strategy, perhaps both should be utilized.

DIAGRAM A

General Research Design

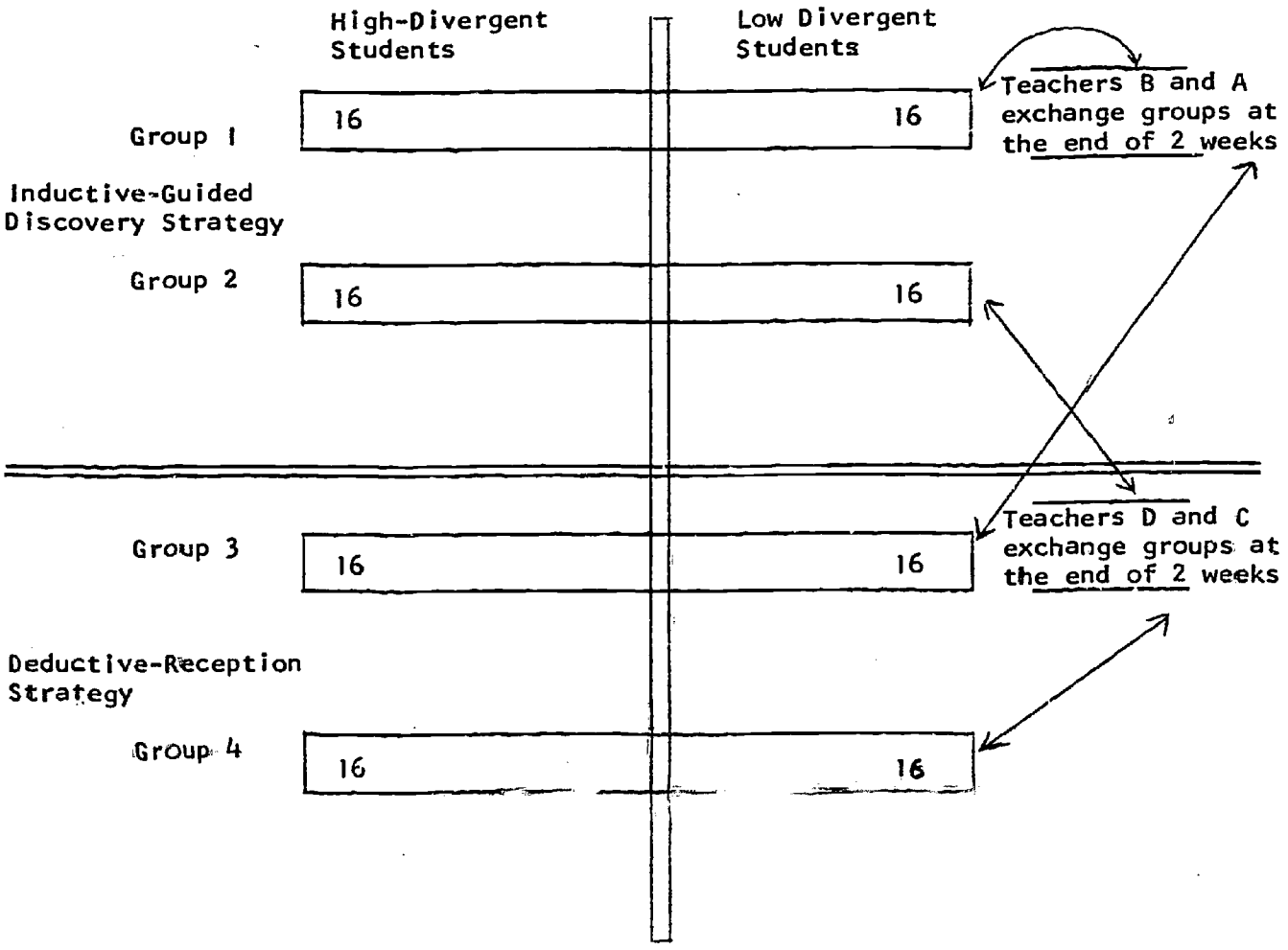

TABLE I

Analysis of Regression of the Independent Variables on the Low Cognitive Sub-Scores of the Test of Acquisition for the Inductive-Guided Discovery Group.*

Independent Variable	Regr. Coeff.	S.D. of Regr. Coeff.	t Values
Grade	6.41	2.11	3.04**
I.Q.	.50	.13	3.86**
Divergent Production Scores	.00	.04	.08 N.S.

* Mean of Low-Cognitive Sub-Scores for the Test of Acquisition (Y) 35.73 S.D. of (Y) 11.82

** $p < .01$

TABLE 2

Analysis of Multiple Regression of Independent Variables on the Low-Cognitive Sub-Scores of the Test of Acquistion for the Deductive-Receptive Group.*

Independent Variable	Regr. Coeff.	S.D. of Regr. Coeff.	t Values
Grade	5.01	1.86	2.69**
I.Q.	.31	.11	2.81**
Divergent Production Score	.04	.03	1.44 N.S.

* Mean of Low-Cognitive Sub-Scores of the Test of Acquisition (Y) = 44.28 S.D. = 9.53

** $p = < .01$

TABLE 3

Analysis of Regression of the Independent Variables on the High Cognitive Sub-Scores of the Test of Acquisition for the Inductive-Guided Discovery Group.*

Indepentent Variable	Regr. Coeff.	S.D. of Regr. Coeff.	t Values
Grade	4.91	1.45	3.40 **
I.Q.	.32	.09	3.59 **
Divergent Production Score	.01	.03	.30 N.S.

* Mean of High-Cognitive sub-scores for the Test of Acquistion (Y) 22.07 S.D. of (Y) 8.15

** $p < .01$

TABLE 4

Analysis of Multiple Regression of Independent Variables on the High-Cognitive Sub-Scores of the Test of Acquisition for the Deductive-Reception Group.*

Independent Variable	Regr. Coeff.	S.D. of Regr. Coeff.	t Values
Grade	3.38	1.75	1.93 N.S.
I.Q.	.36	-.10	3.47 **
Divergent Production Score	.02	-.03	.92 N.S.

* Mean of High-Cognitive Sub-Scores of the Test of Acquisition (Y) = 23.07 S.D. = 8.19

** $p = < .01$

TABLE 5

Analysis of Covariance of I.Q. Scores
on the Test of Acquisition

Criteria Test	Source of Variance	df	Mean Sq.	F Value
Total	Equality of Adj. Cell Means	1	2134.43	8.795 **
	Residual	108	242.68	
High Cog.	Equ	1	3.82	0.063 N.S.
	Residual	108	60.81	
Low Cog.	Eq	1	1760.29	17.396 **
	Residual	108		

** p <.01

TABLE 6

Analysis of Covariance of I.Q. Scores
on the Test of Retention

Criteria Test	Source of Variance	df	Mean Sq.	F Value
Total	Equal of Adj. Cell Means	1	262.45	.979 N.S.
	Residual	108	268.11	
High Cog.	Equ	1	49.78	.647 N.S.
	Residual	108	76.99	
Low. Dog.	Equ	1	545.04	5.30 *
	Residual	108	102.79	

* p <.05

TABLE 6

Estimates of Means

	I.Q.	Test of Acq.	High Cog.	Low Cog.	Test of Reten.	High Cog.	Low Cog.
Inductive-Guided Discovery	102.93	58.05	22.27	36.04	53.04	22.04	30.98
Deductive-Reception	103.62	67.18	22.80	44.20	56.53	20.93	35.60
Total	103.27	62.58	22.53	40.08	54.76	21.49	33.27