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ABSTRACT

Fifteen research reports related to mathematics education are abstracted and analyzed. The reports abstracted were selected from four educational journals and three psychological journals, and deal with a wide variety of topics. The development of children's understanding of diverse mathematical and logical concepts is discussed in four articles, while learning and retention of skills is the subject of two articles. Three reports deal with instructional methods, and two concern teacher education. Topics of other articles include attitudes toward mathematics, learning strategies, problem solving, and a longitudinal study. Research related to mathematics education which was reported in RIE and CIJE between April and June 1974 is listed. (SD)

Vol. 7, No. 3 Summer 1974

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INVESTIGATIONS IN MATHEMATICS EDUCATION

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Summer 1974

MATHEMATICS EDUCATION RESEARCH STUDIES REPORTED IN
RESEARCH IN EDUCATION
April - June, 1974

ED 084 722 Suppes, P. and others, Evaluation of Computer-Assisted Instruction in Elementary Mathematics for Hearing-Impaired Students. 46p. MF and HC available from EDRS.

ED 084 745 Silver, Rawley A. and others, A Study of Cognitive Skills Development Through Art Experiences; An Educational Program for Language and Hearing Impaired and Asphasic Children. 110p. MF and HC available from EDRS.

ED 084 859 DeVault, M. Vere and others, Descriptor for Individualized Instruction; Development Procedures and Results. 150p. MF and HC available from EDRS.

ED 084 871 Fletcher, J. D. and Suppes, Patrick, Computer-Assisted Instruction in Mathematics and Language Arts for the Deaf. Final Report. 45p. MF and HC available from EDRS.

ED 085 091 Hubbard, W. Donald, Developing Mathematical Processes: A Report of the 1971-72 Field Test. 51p. MF and HC available from EDRS.

ED 085 116 Van Wagenen, R. Keith, Formation and Quick Integration of Mathematics Concepts in the Child During the First School Year. Final Report. 46p. MF and HC available from EDRS.

ED 085 119 Webb, Roger A., Concrete and Formal Operations in Very Bright (IQ greater than 160) Six to Eleven-Year-Olds. 13p. MF and HC available from EDRS.

ED 085 204 Exum, Kenith Gene, Evaluation of a Metric Booklet as a Supplement to Teaching the Metric System to Undergraduate Non-Science Majors. 117p. Not available from EDRS. Available from University Microfilms (72-26,540).

ED 085 255 Three Reports on a Study of 11th Grade Mathematics. 75p. MF and HC available from EDRS.

ED 085 256 Halls, W. D. and Humphreys, Doreen, European Curriculum Studies, No. 1: Mathematics. 101p. Only MF available from EDRS.

ED 085 263 Improved Mathematics Curriculum Through Computer Time-Sharing. End of Project Report for Title III, ESEA. 34p. MF and HC available from EDRS.

ED 085 264 Stiglmeier, Lois Mireault, Teachers' Judgments of Pupils' Dependence/Self-Reliance Characteristics Mode of Instruction and Their Relationship to Achievement. 119p. Not available from EDRS. Available from University Microfilms (73-21,485)

ED 085 265 Bunch, Martha Anne, A Study of the Effects on Retention and on the Problem-Solving Ability of Students When Geometry is Used as an Aid in Teaching Factoring of Second-Degree Polynomials. 135p. Not available from EDRS. Available from University Microfilms (73-19,718).

ED 085 266 Skipper, Slade Welpa, A Study of the Use of Manipulative Materials as Multiple Embodiments for the Study of Numeration Systems by Prospective Elementary Teachers. 195p. Not available from EDRS. Available from University Microfilms (73-21,485).

ED 085 267 Gray, Theresa Marie, A Field of Mathematics Laboratory Development in Youngstown, Ohio. 125p. Not available from EDRS. Available from University Microfilms (73-21,242).

ED 085 268 Labaki, Felix George, The Development of a Scale for Measuring the Attitudes of Middle-School and High-School Students Toward Geometry. 95p. Not available from EDRS. Available from University Microfilms (73-23,860).

ED 085 269 Swanson, Richard Eugene, Externally Paced Testing: A New Approach to Measuring Externally Paced Programed Instruction. 125p. Not available from EDRS. Available from University Microfilms (73-23,619).

ED 085 270 Frumess, Suzanne Crew, A Comparison of Management Groups Involving the Use of the Standard Behavior Chart and Setting Performance Aims. 131p. Not available from EDRS. Available from University Microfilms (73-22,904).

ED 085 271 Fry, Dale Eugene, A Comparison of the College Performance in Calculus-Level Mathematics Courses Between Regular-Progress Students and Advanced Placement Students. 109p. Not available from EDRS. Available from University Microfilms (73-23,333).

ED 085 272 Fisher, Merrill Edgar, A Comparative Study of Achievement in the Concepts of Fundamentals of Geometry Taught by Computer Managed Individualized Behavioral Objective Instructional Units Versus Lecture-Demonstration Methods of Instruction. 176p. Not available from EDRS. Available from University Microfilms (73-25,330).

ED 085 400 Colvin, Dan, Evaluation of CPMP (Grades 6-12 Continuous Progress Mathematics Program) 1972-1973. 86p. MF and HC available from EDRS.

ED 085 421 Dragositz, Anna, Ed., Curriculum Innovations and Evaluation: Proceedings of the Association for Supervision and Curriculum Development Pre-Conference Seminar (Princeton, March 8-9, 1968). 103p. MF and HC available from EDRS.

ED 085 457 Evaluation of the Fall River Middle School Research and Development Center Title VII Program, 1972-1973. 127p. MF and HC available from EDRS.

ED 085 857 Burnham, Brian, Reading and Mathematics Achievement of Grade 3 Pupils in Open Plan and Architecturally Conventional Schools--the Third Year of a Longitudinal Study. Studies of Open Education No. 10. 18p. MF and HC available from EDRS.

ED 086 518 Suydam, Marilyn N., Unpublished Instruments for Evaluation in Mathematics Education: An Annotated Listing. 264p. MF and HC available from EDRS.

ED 086 530 Jensen, Linda Rae, The Relationships Among Mathematical Creativity, Numerical Aptitude and Mathematical Achievement. 135p. Not available from EDRS. Available from University Microfilms (73-26,021).

ED 086 531 Posamentier, Alfred S., Mathematical Achievement and Attitudinal Differences Among Students and Attitudinal Differences Among Teachers Under a Two-Semester and a Three-Semester Elementary Algebra Course. 328p. Not available from EDRS. Available from University Microfilms (73-26,728).

ED 086 532 Rohr, Judith Ann Green, The Relationship of the Ability to Conserve on Piagetian Tasks to Achievement in Mathematics. 46p. Not available from EDRS. Available from University Microfilms (73-27,743).

ED 086 533 Smith, James Philip, The Effect of General Versus Specific Heuristics in Mathematical Problem-Solving Tasks. 217p. Not available from EDRS. Available from University Microfilms (73-26,637).

ED 086 534 Wilson, Margaret Patricia, Individual Differences and Instructional Variables in the Acquisition of Structure. 383p. Not available from EDRS. Available from University Microfilms (73-25,674).

ED 086 535 Wilson, John Martin, Jr., Post Mathematical Attitudes Among Prospective Elementary Teachers as Predicted by General Mathematics Skills, Modern Mathematics Skills, Modern Mathematics Achievement, and Prior Mathematical Attitudes. 76p. Not available from EDRS. Available from University Microfilms (73-27,617).

ED 086 536 Hughes, Frank George, A Comparison of Two Methods of Teaching Multidigit Multiplication. 167p. Not available from EDRS. Available from University Microfilms (73-27,731).

ED 086 537 Chinn, James Albert, A Comparative Study of an Audio-Tutorial and a Traditional Method of Teaching Intermediate College Algebra to the Community College Students. 152p. Not available from EDRS. Available from University Microfilms (73-25,126).

ED 086 545 Ludenman, Clinton and others, Final Evaluation Report, Project Video-Tape Packages Mathematics. 61p. MF and HC available from EDRS.

ED 086 548 Allen, Graham, Teaching Behaviour and Pupils' Number Development. 106p. Not available from EDRS. Available from Lawrence Verry Inc., River Road, Mystic, Connecticut.

ED 086 742 Stephens, Charles E., A Multiple Time Sequence Design Applied to Seventh Grade Student Attitude Toward School in Two Schools With Contrasting Organizational Structure. 9p. MF and HC available from EDRS.

ED 086 958 David, Gale, Implications of the Wechsler Intelligence Scale for Children (WISC) Information, Arithmetic, Digit Span, and Coding Subtests of Severely Retarded Readers on Reading Achievement; A Descriptive-Predictive Study. 55p. MF and HC available from EDRS.

ED 087 295 Kohen, Eileen, A Validity Study for the CLEP Introductory Calculus Subject Examination at the University of Illinois. Research Report #349. 21p. MF and HC available from EDRS.

ED 087 422 Palmer, Henry, Three Evaluation Reports of Computer Assisted Instruction in Drill-And-Practice Mathematics. 22p. MF and HC available from EDRS.

ED 087 602 Beckett, Jack, Comp., A Study of Two Methods of Delivering Supplementary Educational Services to Mobile Migrant Children in California. 3p. MF and HC available from EDRS.

ED 087 627 Jay, Winifred Tom, Sex Stereotyping in Selected Mathematics Textbooks for Grades Two, Four, and Six. 168p. Not available from EDRS. Available from University Microfilms (73-28,604).

ED 087 628 Keane, Dorothy Louise, An Exploration and Analysis of the Nuffield Mathematics Teaching Project with Reference to its Current Use in Selected British Schools. 179p. Not available from EDRS. Available from University Microfilms (73-31,740).

ED 087 629 Rebhun, Albert Mitchell, The Reflective-Impulsive Dimension and Mathematical Performance in the Elementary School. 135p. Not available from EDRS. Available from University Microfilms (73-28,970).

ED 087 630 Bargmann, Theodore John, An Investigation of Elementary School Grade Levels Appropriate for Teaching the Metric System. 205p. Not available from EDRS. Available from University Microfilms (73-30,527).

ED 087 634 Pugh, Richard C. and others, An Analysis of Achievement Behavior in Selected Mathematics Courses. 46p. MF and HC available from EDRS.

ED 087 835 An Evaluation of the Corrective Mathematics Services for Disadvantaged Pupils in Non-Public Schools. ESEA Title I Program. 66p. MF and HC available from EDRS.

ED 087 838 An Evaluation of the College Bound Program. ESEA Title I Program. 222p. MF and HC available from EDRS.

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EJ 088 413 Kratzer, Richard O.; Willoughby, Stephen S. "A Comparison of Initially Teaching Division Employing the Distributive and Greenwood Algorithms with the Aid of a Manipulative Material." Journal for Research in Mathematics Education, v4 n4, pp197-204, Nov 73.

EJ 088 415 Harvey, John G.; Romberg, Thomas A. "Educational Research in Mathematics at the University of Wisconsin Research and Development Center for Cognitive Learning." Journal for Research in Mathematics Education, v4 n4, pp243-249, Nov 73.

EJ 088 416 Wiles, Clyde A.; And Others. "The Relative Effectiveness of Two Different Instructional Sequences Designed to Teach the Addition and Subtraction Algorithms." Journal for Research in Mathematics Education, v4 n4, pp251-262, Nov 73.

EJ 088 417 Romberg, Thomas A.; Braswell, James. "Achievement Monitoring Via Item Sampling: A Practical Data-Gathering Procedure for Formative Evaluation." Journal for Research in Mathematics Education, v4 n4, pp262-270, Nov 73.

EJ 088 418 Montgomery, Mary E. "The Interaction of Three Levels of Aptitude Determined by a Teach-Test Procedure with Two Treatments Related to Area. Journal for Research in Mathematics Education, v4 n4, pp271-278, Nov 73.

EJ 088 427 "Research. Tests of Mathematical Attainment for Primary School Children." Mathematics Teaching, n64, pp16-17, Sep 73.

EJ 088 480 Weaver, J. Fred. "Pupil Performance on Examples Involving Selected Variations of the Distributive Idea." Arithmetic Teacher, v20 n8, pp697-704, Dec 73.

EJ 088 640 Aiken, Lewis R. "Ability and Creativity in Mathematics." Review of Educational Research, v43 n4, pp405-432, F 73.

EJ 090 022 Weitz, Lawrence J.; And Others. "Piaget's System of 16 Binary Operations: An Empirical Investigation." Journal of Genetic Psychology, v123 (2nd half), pp279-284, Dec 73.

EJ 090 176 Dossey, John A.; Henderson, Kenneth B. "The Relative Effectiveness of Four Strategies for Teaching Disjunctive Concepts in Mathematics." Journal for Research in Mathematics Education, v5 n1, pp6-19, Jan 74.

EJ 090 177 Sowder, Larry. "High Versus Low Geometry Achievers in the NLSMA Y-Population." Journal for Research in Mathematics Education, v5 n1, pp20-27, Jan 74.

EJ 090 178 Kulm, Gerald; And Others. "The Effectiveness of Textbook, Student-Generated, and Pictorial Versions of Presenting Mathematical Problems in Ninth-Grade Algebra." Journal for Research in Mathematics Education, v5 n1, pp28-35, Jan 74.

EJ 090 179 Lucas, John F. "The Teaching of Heuristic Problem-Solving Strategies in Elementary Calculus." Journal for Research in Mathematics Education, v5 n1, pp36-46, Jan 74.

EJ 090 180 Cathcart, W. George. "The Correlation of Selected Nonmathematical Measures with Mathematics Achievement." Journal for Research in Mathematics Education, v5 n1, pp47-56, Jan 74.

EJ 090 323 Evans, Franklin R.; Pike, Lewis W. "The Effects of Instruction for Three Mathematics Item Formats." Journal of Educational Measurement, v10 n4, pp257-272, W 73.

EJ 090 365 Young, James C.; And Others. "The Validity of the Tests of Achievement in Basic Skills (TABS), Level B, for Predicting Achievement in Elementary Mathematics." Educational and Psychological Measurement, v33 n4, pp909-913, W 73.

EJ 090 366 Holly, Keith A.; Michael, William B. "Comparative Validities and Testing Times for Composites of Structure-of-Intellect Tests and Previous Mathematics Grades with Composites of Traditional Standardized Test Measures and Previous Mathematics Grades in Prediction of Success in High School Modern Algebra." Educational and Psychological Measurement, v33 n4, pp915-919, W 73.

EJ 090 368 Kohler, Emmett T. "The Relationship between the Cooperative Mathematics Test, Algebra III, ACT Mathematics Usage Test, ACT Composite and Grade Point Average in College Algebra." Educational and Psychological Measurement, v33 n4, pp929-931, W 73.

EJ 091 682 Glucksman, Marc D. "The Use of Retesting as a Teaching Device in an Elementary Algebra Course." School Science and Mathematics, v73 n9, pp725-729, Dec 73.

EJ 091 717 Helwig, Carl; Griffin, Shade. "Ninth Graders Teach Arithmetic to Fifth Graders: An Experiment." School Science and Mathematics, v74 n1, pp13-15, Jan 74.

EJ 091 985 Hilton, Thomas L.; Berglund, Gosta W. "Sex Differences in Mathematics Achievement--A Longitudinal Study." Journal of Educational Research, v67 n5, pp231-237, Jan 74.

EJ 092 039 Shumway, Richard J. "Negative Instances and Mathematical Concept Acquisition." Theory into Practice, v12 n5, pp307-315, Dec 73.

9/10

EJ 050 620 270 SE 504 659

LONGITUDINAL EVALUATION OF MATHEMATICAL COMPUTATIONAL ABILITIES OF NEW HAMPSHIRE'S EIGHT AND TENTH GRADERS, 1963-1967. Austin, Gilbert R; Prevost, Fernand, Journal for Research in Mathematics Education, v.3 n1, pp. 59-64, Jan. 1972.

Descriptors--*Achievement, *Curriculum Evaluation, *Longitudinal Studies, *Mathematics Education, *Research, Arithmetic, Grade 8, Grade 10, Instruction, Modern Mathematics

Also reported in:

EJ 066 424; THE RESULTS OF A LONGITUDINAL STUDY IN MATHEMATICS IN NEW HAMPSHIRE. Austin, Gilbert R; Prevost, Fernand, Mathematics Teacher, v.65 n8, pp. 746-747, Dec. 1972.

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Donald J. Dessart, The University of Tennessee, Knoxville.

1. Purpose

The purpose of the study was to compare three groups of students (those who had studied from modern, traditional, and transitional textbooks) of grade eight during the fall of 1965 on the bases of measures of mental abilities, arithmetical computational skills, and abilities to understand mathematical concepts. Similar comparisons were made of students of grade eight during the fall of 1967, and comparisons were repeated in 1967 of those students who had been eighth graders in 1965.

2. Rationale

In the fall of 1963 in the state of New Hampshire, the median raw score of students in grade eight on the Arithmetic Computational subtest of the Metropolitan Achievement Test was equal to a grade equivalency of 8.8. In the fall of 1967, a grade equivalency of 6.8 was obtained for students of grade eight who had taken the Arithmetic Computational subtest of the Stanford Achievement Test. Consequently, there was a decline of two years in the computational grade equivalencies from 1963 to 1967 on these two tests.

A decline in computational scores had been observed previously in 1964, and in 1965 a further decline prompted the New Hampshire State Department of Education to initiate a study with the Bureau of Educational Research and Testing Service at the University of New Hampshire. It was felt that there might exist relationships between these declines and the curricular changes that had taken place in New Hampshire during the years of the modern mathematics movement.

3. Research Design and Procedure

The 4,724 eighth grade students tested in the fall of 1965 in New Hampshire were placed in one of the following categories: "Modern," "Traditional," "Transitional," or "Other" based upon a classification of the textbooks from which the students had studied during the previous three years (grades five, six, and seven). Students classified in the fourth category (Other) were excluded from the study.

The criteria used to classify the textbooks were as follows:

a) Modern: Textbooks that placed emphasis upon the development of concepts and concrete manipulations (such as those used in the California strands development) or textbooks stressing mathematical systems, properties, functions, and graphs.

b) Traditional: Textbooks that stressed computational techniques in a manner similar to those texts used in many schools during the late 1950's or early 1960's. These texts seldom emphasized structure in concept development and frequently contained long lists of computational exercises.

c) Transitional: Textbooks that reflected a "middle of the road" approach between the two types of texts described in a) and b) above.

The three groups of students: Modern (1,215 students), Traditional (591 students), and Transitional (2,376 students) were tested during the fall of 1965 using the Otis-Gamma Intelligence Tests, and the Metropolitan Achievement Test (arithmetic computation and concepts subtests). The scores were subjected to a one-way analysis of variance.

In 1965 a classification scheme similar to that described above was used to categorize 4,657 eighth grade students into the groups: Modern (2,268 students), Traditional (514 students), and Transitional (1,875 students). These groups were tested with the School and College Ability Tests (SCAT) and the three subtests of the Stanford Test: Arithmetic Computation, Arithmetic Concepts, and Arithmetic Applications. These scores were also analyzed through a one-way analysis of variance.

In 1967, the eighth graders of 1965 (now in the tenth grade) were tested again using the SCAT, Form 2B; the Numerical Competence and Mathematics subtests of the Stanford Test. Due to changes in both the schools and their student populations, only 3,439 of the 4,182 students originally examined were tested a second time. Results were analyzed in a manner similar to the previous two phases of the study.

4. Findings

Eighth Graders, Fall 1965. In the fall 1965 testing, statistically significant differences ($p \leq .05$) were found among the means of the three groups on the Otis-Gamma Intelligence Test. In order, the means were: Modern (36.69), Transitional (34.70), and Traditional (33.59). On the Computation subtest of the Metropolitan Achievement Test the results, in order, were: Traditional (30.08), Transitional (29.22), and Modern (28.56). As one can see, the Modern Group scored highest in the intelligence testing but scored lowest in the test of computational skills.

No statistically significant differences were found among the three groups in the Mathematics Concepts test of the Metropolitan Achievement Test.

Eighth Graders, Fall 1967. In the fall 1967 testing, statistically significant differences ($p \leq .01$) were found among the means of the three groups in most of the testings with the Modern Group scoring highest in all testings with mean results as follows: SCAT Verbal (32.60), SCAT Quantitative ([illegible]1.89), SCAT Total (54.49), Stanford Computation (19.00), Stanford Concepts (20.50), and Stanford Applications (14.94). The Traditional and Transitional Groups tended to share second and third places on these tests about equally with no really consistent pattern of results.

Tenth Graders, Fall 1967. (Eighth Graders of 1965). In the fall 1967 testing of tenth graders, statistically significant differences in the three groups were not found in the SCAT nor the Numerical Competence portion of the Stanford Test. In the Mathematics portion of the Stanford Test the Modern Group scored significantly ($p \leq .01$) higher than the Traditional Group (means of 26.09 and 19.41, respectively) but did not significantly out-distance the Transitional Group (means of 26.09 and 25.68, respectively).

5. Interpretations

The authors offered a number of interpretations, notable among these being:

(a) The scores obtained by the three groups on tests of computational skills declined from 1963 to 1965 and from 1965 to 1967. The authors observed that teachers tended to spend less time on drill and practice of computational skills in 1967 than in 1963 and more time on understanding of arithmetical properties.

(b) The data appeared to indicate that the groups were different intellectually in 1965 with the most able group (the Modern) performing most poorly on a test of computational skills. But in 1967 the abilities of the groups appeared to be about the same and their computational abilities were about the same. The authors hypothesized that "...when general ability is taken into consideration, the type of mathematics textbook used does not differentially affect the ability of students to do computational arithmetic."

(c) In the tenth grade testing of 1967, the Modern Group outperformed the Traditional Group in the mathematics portion of the Stanford Test leading the authors to conclude that the "payoff" of the modern programs may come in the ability of students to perform well in algebraic and geometrical studies where "understandings" are of greater importance than computational skills.

Abstractor's Notes

During times when educational research comes under such heavy criticism because of its frequent lack of relevancy to classroom practice, it is refreshing to find a study that has such immediate application to classroom policies. The loss in computational skills from 1963 to 1967 of the New Hampshire students has led to a readjustment in the school mathematics programs of New Hampshire to provide closer attention to the development of computational skills. The additional hypothesis that the modern programs appear to have their "pay-off" in greater student success in algebra and geometry will hopefully temper this emphasis upon computational skills, so that we will not see a return to the "rule-example-drill" syndrome of the past. Of course, the virtually untapped resource of hand calculators will provide more exciting opportunities to develop computational skills with meaning and understanding.

The loss in computational skills was based upon the results of testing with two different instruments. Although the authors stated that this change of tests provided some problems in interpreting the data and that these problems were not serious, one might wonder about the degree of comparability of the norming groups for the two tests. Their comparability would seem to be a crucial element in valid comparisons of grade equivalencies.

The entire question of the desirability of emphasizing the development of computational skills probably at the expense of other mathematical understandings is a value judgment that teachers must make. But it seems highly desirable that they have available the results of research such as reported in this study to aid in making such important educational decisions.

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EJ 057 929 310 SE 505 927
THE CONSISTENCY OF STRATEGIES IN THE LEARNING OF MATHEMATICAL STRUCTURES. Branca, Nicholas A.; Kilpatrick, Jeremy, Journal for Research in Mathematics Education, v.3 n3, pp. 132-140, May 1972.

Descriptors--*Educational Games, *Learning Processes, *Mathematics Education, *Research, Mathematical Concepts, [*Learning Strategies]

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Merlyn J. Behr, Northern Illinois University.

1. Purpose

The authors suggest that a subject's sequence of questions or moves which lead toward the solution of a given task should be called a strategy only if a similar sequence is observable when subjects perform on a similar task. To investigate this consistency of subjects' questions or moves across game like tasks based on different embodiments of the same group structure and between two different mathematical structures was the purpose of this study.

Four separate hypotheses were stated for investigation.

1. The distribution of evaluations for each of the group-structure tasks follows the same order as that reported by Dienes and Jeeves.

2. The hierarchy of evaluations for each of the group-structure tasks is in the same order as that reported by Dienes and Jeeves.

3. Subjects' evaluations and strategy scores are consistent across the two group-structure tasks.

4. Those subjects who give a particular evaluation and use a particular strategy on the two group-structure tasks perform in a similar way on a third task.

2. Rationale

This work replicates and extends work reported by Dienes and Jeeves in 1965 and 1970 in which they had identified three so-called strategies, called memory, pattern and operator, based on moves subjects made in learning a colored card game embodying the structure of a mathematical group. They presented evidence that a subject's retrospective account (evaluation) of how the game worked reflected the moves he had made in playing it. They devised two scores - a pattern score and an operator score. The pattern score reflected the proportion of the subject's plays that were within a given region of the group talk. The operator score reflected the proportion of the subject's plays in which the same card was played repeatedly in succession. The work of Dienes and Jeeves dealt with issues of whether there exists a hierarchy of strategies and evaluations, whether there are sex and age differences, and how the learning of one group structure affects the learning of another group structure; their work left uninvestigated the concern of this study.

An apparent assumption on which this study is based is that subjects' transfer of a sequence of moves from one task to another depends on the stability of that sequence; that is, whether or not the sequence has become a strategy.

3. Research Design and Procedure

The subjects for the study consisted of 100 junior and senior high school girls. This sample was divided into two groups - older and younger.

Three tasks were used in the study; two were game embodiments of the Klein group, and the third an embodiment of a network structure. The first embodiment of the Klein group employed the color game developed by Dienes and Jeeves, the second employed a game involving a combination of lights and switches. In both cases subjects were to learn the Klein group structure by learning the rules of the game. The network structure was embodied by a map game. Various moves on the map enabled subjects to ascertain the structure of the network.

Each of the three games were played with each of the subjects individually and in the order presented above. The interviewer recorded the subject's moves and predictions and the evaluation she gave at the end of the interview. Scores were computed for each subject as in Dienes' and Jeeves' work.

4. Findings

A subject was classified as successful on a task if she gave an evaluation of the game that accounted for 14 or more of the 16 binary combinations. By this criterion 49, 47 and 54 subjects were successful on the three games, respectively. No comparison of this data with Dienes or Jeeves was possible, since they did not report this data.

An investigation of the relationship between evaluations and strategies showed a direct contrast to findings of Dienes and Jeeves. Successful subjects who gave an operator evaluation on the color game did not tend to have higher operator scores than successful subjects who gave other evaluations. The results of the light game were similar. Some evidence of a relationship between evaluations and strategies existed on the map game.

The authors interpret the data as giving the following information concerning the stated four hypotheses respectively:

1. On both games the distributions of evaluations were in the same order of frequency as that reported by Dienes and Jeeves.

2. On both games the distributions were in the same order as reported by Dienes and Jeeves.

3. When the data from all 100 subjects was taken a X^2 test suggested more consistency than change. When the data from 38 subjects successful on both tasks was taken, a X^2 test again showed consistency. Consistency was shown for subjects' evaluations, both when the data for the total sample of 100 was subjected to a X^2 test and also when the data for the 38 subjects who were successful on both tasks was analyzed. Consistency was shown for operator scores on the two tasks as well; however, the pattern scores did not show consistency.

4. Hypothesis 4 was not investigated as stated due to the difficulty of tasks and lack of relationship between evaluations and strategy scores. However, the authors report the following trends: i) Subjects who gave the same evaluation on both group structure tasks showed no more tendency than the other subjects to give a particular evaluation on the map game; ii) Subjects who were successful on both tasks tended to give a common type of evaluation; iii) Subjects who were successful on both group structure tasks tended to have a high score on a particular strategy while subjects unsuccessful tended to have a low score on the same strategy.

5. Interpretations

The greater difficulty of the group structure tasks in this study, compared to those of Dienes and Jeeves, is partially explained by the fact that subjects in Dienes' study were participating in a special mathematics project and had solved problems involving group structures before. Although support was obtained for Dienes' and Jeeves' conjecture that the relative frequency of evaluations would correspond to a hierarchy of evaluations, the evidence would be more impressive if one could be confident that subjects' evaluations reflected an underlying strategy of moves. The authors conjecture that the strategy scores defined by Dienes and Jeeves are insensitive to the strategies subjects may have employed. While Dienes' and Jeeves' research may have given a productive new focus to research on strategies, the findings of the present study should alert researchers to the fact that strategies postulated by Dienes and Jeeves have not been shown to exist. Although subjects do show some awareness of regularities in how they play the games through reflective thinking, the critical tie between the awareness and the regularities in their sequence of moves has not been convincingly shown to exist.

Abstractor's Notes

The following would have been useful additions to the study and report.

1. A counterbalanced design to determine whether task order effects existed.

2. More detail concerning the description of the two games invented by the authors would be useful. Replication of this study would prove difficult without correspondence with the authors.

3. More extensive piloting of the tasks could have alerted the authors to the task difficulty for the sample population.

4. A possible alternative scoring system to that employed by Dienes and Jeeves and also in this study would have been welcomed.

5. A welcome discussion would have been about whether subject's strategies in solving game problems related to group structures has a possible relationship to their problem solving strategies or general learning activity.

6. The authors do not suggest whether or not they concur with Dienes' and Jeeves' hierarchy of moves in which an operator's move is "at the highest level"; however, this would have been a welcome discussion.

Merlyn J. Behr
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EJ 041 139 310 PS 501 180
NUMBER CONSERVATION IN VERY YOUNG CHILDREN: THE EFFECT OF AGE AND MODE OF RESPONDING. Calhoun, L. G., Child Development, v.42 n2, pp. 561-572, Jun 1971.
Descriptors--*Age Differences, *Response Mode, *Pre-school Children, *Conservation (Concept), *Cognitive Development

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Elizabeth Fennema, University of Wisconsin-Madison.

1. Purpose

To clarify the effects of response mode and age on number conservation responses of children between 2-3 (two years and three months) and 4-7 years old.

2. Rationale

Although studies are limited with young children (under 4 years of age) some researchers on conservation of number have reported a decrement of correct conservation responses in 3-3 to 4-4 year old children when these responses are compared with conservation response of younger children. Other types of studies as well as conservation studies have suggested that stimulus materials employed can produce variation in the number of correct responses on number conservation tasks. Therefore, this study was undertaken to give further information on number conservation of very young children (2-4 to 4-7 years of age) and on the effect of two different modes of response, i.e., eating and pointing.

3. Research Design and Procedure

Subjects were 26 boys and 30 girls distributed over the age range 2-4 to 4-7 years enrolled in or siblings of those enrolled in private nursery schools. One subject who appeared intellectually deficient was eliminated. A typical number conservation task was administered 10 times utilizing brown M & M candy as the stimulus material. On half of the trials the child was asked to point to the row that had the most and on half the trials she/he was asked to eat the row that had the most. The responses of subjects younger than 2-8 years were eliminated because they did not respond appropriately to the task (indiscriminately picked candy from either row).

4. Findings

The means indicate a decrement in response between 3-0 to 3-7 years of age with an overall increase in response from 2-8 to 4-7 years of age. A 6(age) X 2(response mode) ANOVA resulted in a nonsignificant F ratio for mode of response and significant F ratios for age ($p < .01$) and age X response ($p < .05$). In one age range only (3-0 to 3-4 years) was a significant F ratio found for response mode. At this age higher scores were reported for the eating mode. No significant differences were found between consistent conservers and nonconsistent conservers in each age group when only the eating response was considered but significant differences were found in the 3-0 to 3-3 and 3-4 to 3-7 age groups when the pointing response was considered.

5. Interpretations

These results confirm that the very young child does have the ability to conserve number and then goes through a period when this ability decreases. The results also suggest that more highly motivating stimulus material (i.e., eating) helps a child overcome whatever factors limiting his conserving ability during the time when the decrement occurs. The decrement in correct responses to the number conservation task occured earlier than in other reported studies, and may have been because of the population sample or the stimulus materials used. These results suggest that the very young child can conserve number if the response mode is not verbal.

Other Piagetian scholars have reported that children in the age range considered here cannot conserve. This inconsistency of findings may be due to the operational definition of conservation used. In this study a nonverbal response was considered as evidence of conservation while in other studies verbal encoding was required.

Abstractor's Notes

This is a replication study of which more are needed. The study is reported within a sound theoretical framework, reported well and adequately discussed. As such, it has value.

The best part of this study is the discussion section in which the operational definition of conservation is clarified. The results of the study are in conflict with other Piagetian scholars and this conflict is rationally explained in terms of the response required of the subject.

In spite of this excellent discussion and the clarity of reporting, the abstractor questions the validity of the study. An attempt was made to have response modes appropriate to young children. However, does this type of study really elicit the child's ability to conserve or is a more informal technique which would let the interviewers response to a child's idiosyncracies more appropriate? What if a child does not like M & Ms? That would immediately invalidate one subject's response and presumably the data from this subject would still be included.

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EJ 032 359 340 PS 500 830
BEFORE CHILDREN CAN MEASURE. Carey, Russell L.; Steffe, Leslie P., Elementary School Journal, v.71 n5, pp. 268-292, Feb. 1971.
Descriptors--*Mathematical Concepts, *Conservation (Concept), *Early Childhood Education, *Transformations (Mathematics), Language Role, Mathematics Instruction, [*Piaget (Jean)]

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Marilyn N. Suydam, The Ohio State University.

1. Purpose

To determine the effect of selected premeasurement experiences on the ability of children to establish a length relation between two curves.

2. Rationale

Since "it is apparent from research studies on child development that quantitative activities and activities that require logical-mathematical thought processes may not be appropriate for most pre-school children . . . it does not appear feasible to teach measurement to preschool children. It seems necessary to identify qualitative activities that will help develop skills desirable for later activities that may aid in the development of logical-mathematical thought processes. The skills may eventually be applicable to instructional situations in measurement." (p. 288)

3. Research Design and Procedure

Three guidelines, drawn from the literature, were used in constructing experiences designed to teach children the relations "longer than", "shorter than", and "the same length as": (1) have children participate actively with concrete materials, (2) consider the role of language, and (3) make sure that the activities are consistent with the operational definitions of the relations. These guidelines were applied in developing premeasurement activities with the emphasis on comparisons. Specific examples are provided.

Subjects were 20 four-year-olds and 34 five-year-olds in three self-contained classrooms in one school in Georgia. The Peabody Picture Vocabulary Test was used to measure verbal maturity (range of scores at age 4, 83 to 119; at age 5, 55 to 120). The Stanford-Binet Intelligence Scale, Form L-M, was used to measure intelligence (range at age 4, 98 to 145; at age 5, 81 to 130). Social class was measured by the Hollingshead Two Factor Index of Social Position (range from I, high, to V, low).

Children were taught, in groups of six for seven 20- to 30-minute sessions, to establish a length relation between two curves. An 18-item test, involving six sets of materials with one item on each set related to each relation, was administered by specialists before and after instruction. A repeated measures design was used to analyze scores on the total test and on subtests.

4. Findings

The mean score on the posttest was significantly higher than the mean score on the pretest. Gains on the "longer than" subtest were not statistically significant; gains on the other two subtests were statistically significant.

	"longer than" subtest		"shorter than" subtest		"the same length as" subtest	
	pre	post	pre	post	pre	post
age 4	68%	78%	43%	76%	48%	57%
age 5	75%	86%	61%	91%	46%	80%

5. Interpretations

"It may be concluded that formal experiences in comparing qualitative length significantly improve the ability of four- and five-year-olds to compare lengths. A length comparison test given to these children after the study was completed showed that they had the ability to use the relations in novel length comparison situations." (p. 292)

Abstractor's Notes

The article appears to be planned as much to discuss premeasurement and measurement expectancies and activities as to present the research study. The two are blended together well: the reader is led from background information into the study. (Many readers might not realize it is a research report until they are well into the article.) The presentation is generally at a level at which most teachers should have no difficulty in reading and interpreting; e.g., data are reported in terms of percentage of increase. We are told that a repeated measures design is used, and that results were or were not statistically significant, but the statistical test information is avoided. An article must be written to its anticipated readers, and the anticipated readers in this case appear to be teachers, not researchers.

Ranges of scores on three variables (verbal maturity, intelligence, and social class) are reported, but no explanation of their role in the study is given: do they merely describe the sample?

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CHILDREN'S UNDERSTANDING OF NEGATION AS A LOGICAL OPERATION. Feldman, S. Shirley, Genetic Psychological Monographs, v.85, pp. 3-49, Feb. 1972.

Expanded Abstract and Analysis Prepared Especially for I.M.E. by John Gregory, University of Florida.

1. Purpose

This article presents a series of six studies designed to discover what children understand of negation as a logical connective, the variables that affect this understanding, and the relationship between negation and other logical abilities.

2. Rationale

This research effort was seen as a much needed replication and extension of the work of Piaget and others investigating children's understanding of the negation concept. The extension took the form of a more complete analysis of the data (qualitatively as well as quantitatively) and increased standardization in the experimental situation.

3. Research Design and Procedure

All six studies employed an interview format in which the subject was to select objects (for the most part, attribute blocks) upon the basis of an interviewer's command. Each study involved at least 100 Ss for a total of 440 Ss (one sample was used for three studies). Age (defined as Nursery School vs Kindergarten in three studies; 3,4,5,6, or 7 years of age for three studies) and sex constituted two of the independent variables in each study. Other independent variables are included below in the brief description of each study. The dependent variable was correctness of response (both frequency and proportion). Data was subjected to analyses of variance, correlation and z tests of proportion. In the sixth study, performance on class inclusion tasks served as an additional dependent variable. Post hoc analysis included tests of the differential distribution of errors.

4. Findings

Study 1. The interview contained a total of 12 commands. The following variables were considered in tasks involving a single attribute (numbers in parentheses indicate the number of commands for each variable level): presence or absence of negation (4 vs 8); linguistic forms "things not X" vs "not-X things" (4 vs 4); color or shape (6 vs 6). Significant Results: negation commands were more difficult than positive commands; "things not X" idiom was easier;

more correct responses were made to color attribute commands. More errors of ignoring the negative occurred under the "not-X things" idiom whereas more errors of providing only one of the two disjoint subsets constituting the correct response were made under the "things not X" idiom.

Study 2. The interview contained 12 commands. The following variables were investigated in tasks involving the negation of two attributes: linguistic forms "things not XY" vs "not-XY things" (6 vs 6); intra-individual consistency. There was a trend for more correct responses to be made to the "things not XY" and responses were consistent under both idiom types. The error of ignoring the negative occurred more for the form "not-XY things."

Study 3. The interview contained 13 commands which provided for analyses of the following variables: negation of 1 or 2 attributes (insufficient information; either 4 vs 9 or 4 vs 4); idioms within command types: "X things that are not Y" vs "X not Y (things)" (2 vs 3, TYPE 1), "everything except the X" vs "everything but the X" (2 vs 2, TYPE 2); and a third command type comprised of the two stages "Give me the X. Now give the things that are not X." Age was a significant variable (nursery/kindergarten). Number of attributes negated was also significant (one/two). Under TYPE 1, the "X things that are not Y" idiom was easier. Under TYPE 2, a three way interaction, age X sex X idiom, indicated that nursery school boys perform better on "but" commands, while kindergarten boys do better on "except" commands. Under TYPE 3, there was a significant interaction between age and number of attributes negated. Space does not permit presentation of the results of error analyses.

Study 4. Six commands of negation involving one attribute constituted the interview. The number of objects in the complementary set (in addition to age and sex) was investigated. Two commands were given for each of the following sets of correct responses: $\overline{X3}$ (3 blocks), X9 (9 blocks), $\overline{X15}$ (15 blocks). Eighteen blocks were used for each command. An interaction between age and number of objects was found. X3 was easier than $\overline{X9}$ and $\overline{X15}$ for all but age 3 Ss. At ages 3, 4, and 5 more correct responses were made to $\overline{X9}$ than $\overline{X15}$ and to $\overline{X3}$ than to $\overline{X15}$. Most errors were made due to partial correct response.

Study 5. Nine commands were used to generate responses in relation to familiarity of attributes asked for. Dolls (familiar objects), common shapes such as squares, stars, etc. (moderately familiar), and uncommon shapes for which children could not provide a label (determined in a pilot) were employed. At ages 4, 5, and 7 common shapes evoked more correct responses than either the dolls or uncommon shapes. At age 4 uncommon shapes were easier than dolls; at age 6 this was reversed. Girls performed better than boys on all tasks, at all age levels. Differential distribution of errors were also reported.

Study 6. The last study sought information as to the sequential relationship (a la Piagetian stage development) between negation and class inclusion. The sample was the same as that used for studies 4 and 5, with a mean interval of 7 days between that interview and this one. Twenty questions constituted the four subtests; two sets of materials (beads and animals) and two different cardinalities of the (9 and 12 out of 18). No significant differences were found in the class inclusion tasks. Correlation coefficients between negation (from the earlier studies) and class inclusion revealed no consistent pattern. Three year olds, five year olds, and the total sample yielded significant correlations for the two variables. A chi-square analysis of one or no errors on negation and class inclusion tasks was significant thus suggesting that a form of negation precedes class inclusion.

5. Interpretations

1. Children's understanding of negation as a logical operation develops slowly with age and experience.

2. Negation involves a cognitive operation and is not merely a problem of semantics.

3. Common errors in response to negation commands reveal basic difficulties in logical operations.

4. Familiarity of material was a highly significant variable as was the number of objects in the complementary set.

Abstractor's Notes

There are two striking features of this report: the presentation of a program of research rather than an isolated study, and the depth of analysis of errors made by the subjects. At first reading of the report, one might think that what was really being investigated was how to confuse children through a variety of commands. The interpretation of differential performance under varying linguistic forms is however, important in gaining insight into the process of logical thought.

Since it was found in Study 1 that color vs shape was significant, it would have been interesting to find out if this relationship existed in the later studies. Since no data (means nor s.d.) were reported, no inferences about this relationship or others can be made.

One possible explanation for the difficulty of the class inclusion tests is the use of the conditional logic paradigm in 12 of the 20 questions. Investigations have found that conditional reasoning ability develops at a much later age than that of the children involved in these studies.

Future investigations will benefit from the limitations noted by the author -- overlapping ages when using nursery school vs kindergarten and non-control for SES. Replication of particular aspects of these studies is needed which will increase the number of possible correct responses by Ss. With so many variables, some of the findings of this report were based on one command only (Study 3). An increase in the number of commands would also allow for determination of reliability of the tests (interview). Categorization or errors should be continued, but since this practice increases the difficulty in coding (these studies used 15 categories of responses), some coding reliability check should be performed.

John Gregory
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EJ 050 326 180 SE 504 654.
DIAGNOSING SELECTED BEHAVIOR CHARACTERISTICS OF TEACHERS OF SECONDARY SCHOOL MATHEMATICS. Flora, Ben V., Jr., Journal for Research in Mathematics Education, v.3 n1, pp. 7-20, Jan. 1972.

Descriptors--*Diagnostic Tests, *Mathematics Education, *Research, *Teacher Behavior, *Teacher Evaluation, Effective Teaching, Predictive Measurement, Preservice Education, Test Construction

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Thomas J. Cooney, University of Georgia.

1. Purpose

Three questions concerned with providing a measure of selected teacher behavior characteristics of secondary school mathematics teachers were investigated using a paper-and-pencil instrument called the Teaching Situation Reaction Test for Teachers of Secondary School Mathematics (TSRT-TSSM).

"1. Do the profiles of secondary school mathematics teachers classified as highly effective establish significantly different patterns form those teachers classified as minimally effective?

2. Does the profile produced by the instrument for a given individual provide a reasonably accurate description of this individual with regard to the characteristics being measured?

3. If the instrument is used in a methods course as a means of providing a student with knowledge concerning his profile and profiles which are characteristic of highly effective and minimally effective teachers of secondary school mathematics is there a change in the student's behavior, as indicated by the profile, on a readministration of the instrument?"

2. Rationale

Research on identifying characteristics of effective teachers has become more interested in characteristics of teaching behavior than in characteristics of teachers. The present study considers both a "characteristics" and a "behavior" base through the development of TSRT-TSSM.

3. Research Design and Procedure

The instrument contained ten teacher-behavior-characteristic dimensions: (1) student capabilities and efforts for learning mathematics, (2) understanding of pupils, (3) self confidence, (4) acceptance by others, (5) capabilities of other teachers,

(6) planning and management, (7) classroom procedures and methods, (8) student participation, (9) goals for teaching mathematics, and (10) educational viewpoint.

Fifty paper-and-pencil items were constructed using a critical incident technique to measure an individual's response to hypothetical teaching situations. The items were used as indicators of the ten dimensions, five items for each dimension. Each item was scored 0-6. The ten scores (0-30 points for each dimension) provided the profiles in question.

To provide information relative to the first two questions posed above, the test was administered to the following samples: experienced teachers, nine classified as highly effective, six as averagely effective and six as minimally effective as determined through professional judgments and various inventories (Sample R), a second group of 27 inservice teachers participating in an NSF summer institute who were also classified as highly effective or minimally effective (Sample I), 20 preservice teachers enrolled in a first methods course five of whom were classified as highly effective and five as minimally effective based on academic performance (Sample M), and 14 preservice teachers with student teaching experience who were also classified as highly or minimally effective (Sample S).

The test was also administered to preservice teachers enrolled in a second methods course (Sample T). Five weeks later these subjects were provided with information from their test profiles and comparisons were made with profiles of identified highly effective teachers. Three weeks later the instrument was readministered to this sample.

The Mann-Whitney U Test was used to compare scores for highly effective and minimally effective teachers for samples R, S, and M. This test was also used to indicate TSRT-TSSM's ability to distinguish the "predicted" best teachers from the "predicted" poorest teachers using the initial testing of samples M, S, and T. Product-moment correlations were used to determine test-retest reliabilities for Samples M and I. Subjects in Sample S were administered the test three weeks apart with instructions for the second test to obtain a good score. These test-retest results for Sample S were used to provide information concerning the resistance of the instrument to faking.

4. Findings

The following findings were given by the author:

1. Total test scores (as well as scores on some dimensions) for highly effective teachers were significantly higher (.05) than for minimally effective teachers for Samples R, M and S. Further, profiles of the two groups were significantly different (.05).

2. Reliability measures (product-moment correlations) or .90 and .85 with standard errors of 4.32 and 7.82 were obtained respectively for samples M and I.

3. Data from Sample S indicated non-significant gains in test scores.

4. TSRT-TSSM yielded significant results (.05) for distinguishing between "predicted" best teachers and the "predicted" poorest teachers for samples M and S. Results for Sample T were not significant.

5. Significant gains were noted for Sample T for Dimensions 4, 6, 7, 8, 9 and the total test.

5. Interpretations

The author's conclusions contained the following:

1. Profiles of highly effective teachers were significantly different than those of minimally effective teachers with respect to Dimensions 6, 7, 8, and 9.

2. TSRT-TSSM scores for highly effective teachers are significantly greater than those of minimally effective teachers.

3. There is evidence that suggests that resulting profiles do provide reasonably accurate descriptions of individuals with regard to the characteristics purported to be measured.

4. The instrument has satisfactory test-retest reliability and is resistant to faking.

5. The TSRT-TSSM can predict the degree of success in student teaching and in a first methods course.

6. When the instrument is used to provide methods students information about their profiles and about profiles of highly effective teachers, a significant gain can be expected on Dimensions 4, 6, 7, 8, and 9 upon retesting.

Abstractor's Notes

There are certain limitations that must be considered with respect to TSRT-TSSM. The first involves the investigator's assumption that the instrument reasonably reflects teachers' beliefs and that teachers will teach in accordance with those reflected beliefs. There is some evidence to support this assumption. The smallness of the sample size is another factor which limits the generalizability of the instrument.

Additional limitations stem in part from the very nature of the research. Since TSRT-TSSM was devised through a critical incident technique, the following limitations should be considered. First, general principles concerning characteristics of teacher behavior established for a large group of teachers are not always applicable to individual teachers. Second, characteristics judged desirable may not always be so across all situations (grade level, type of class, etc.) or across all teachers. Third, teacher behavior characteristics that are currently assessed may not be representative at a later time or in settings other than those investigated. Each of these has implications for the use and interpretation of results from TSRT-TSSM.

The use of the instrument as a diagnostic tool evidently consists of providing information to the preservice teachers about their profiles and profiles of highly effective teachers. To what can the increase in test scores from the first to the second test be attributed? Surely there was self-analysis by the subjects. But whether the increase reflects a real change in teacher behavior characteristics or only a more subtle test taking approach by the subjects is not clear.

It is also not clear from the study as to how the instrument was used to verify that highly effective teachers differ from minimally effective teachers and how the instrument was used to predict highly effective and less effective teachers. Apparently the same samples (R, M, and S) were used in both aspects of the question.

Despite these questions and limitations, the investigator appears to have constructed a viable instrument which can be of use in teacher education programs. The investigator's suggestion that the instrument be used in classes other than in mathematics has merit. Since the instrument has its roots in a general education viewpoint, such an extension seems natural and desirable.

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EJ 055 232 450 SE 505 357
COMPUTER-ASSISTED PROBLEM SOLVING IN SCHOOL MATHEMATICS. Hatfield, Larry L.; Kieren, Thomas E., Journal for Research in Mathematics Education, v.3 n2, pp. 99-112, March 1972.
Descriptors--*Computer Oriented Programs, *Instruction, *Programing, *Research, *Secondary School Mathematics, Achievement Tests, Computer Science Education, Grade 7, Grade 11, Problem Solving

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Arthur F. Coxford, The University of Michigan.

1. Purpose

The report attended to the following questions:

a. Does the activity of writing, executing, and studying the output of computer programs related to problems in the regular mathematics curriculum affect mean student achievement in mathematics?

b. Are students of varying levels of prior mathematics achievement differentially affected by use of the computer?

c. Are there curricular areas where the use of the computer particularly contributes to or detracts from mathematics achievement?

2. Rationale

Computer programming requires the learner to analyze and to understand thoroughly the mathematical concepts and procedures in use. Thus it should serve to reinforce and clarify concepts and procedures being studied. Additionally, with some programming skill, the learner can generate and manipulate data for use in the exploration of mathematical questions. These hypothesized benefits of the computer suggest the utility of the computer program as a dynamic problem-solving tool.

3. Research Design and Procedure

Two experiments were each run over two years and for two grades: 7 and 11. At each grade level the students were randomly assigned to the computer or the noncomputer class. At each grade level the same teacher taught both classes. The only planned difference in the classes was that the computer classes wrote and processed computer programs involving the problems, concepts, and skills from the regular mathematics course while the noncomputer classes used the computer in no way. The variable measured at each grade level was achievement in mathematics. No tests measuring skills or knowledge of the computer were given. A total of 103 seventh and 81 eleventh grade students participated in the study.

During the school year in the seventh grade classes, unit tests were given. Likewise at the end of the year, performance was assessed with a teacher constructed comprehensive test and the following standardized tests: COOP Structure of the Number System, Contemporary Mathematics Test, STEP Mathematics 3B, and Iowa Test of Basic Skills. At the end of year two, an additional post test called Thought Problems was given. The seventh grade students were partitioned into high, average, and low groups on the basis of previous mathematics performance. The test items were partitioned into skill, concept, and problem categories. Thus analysis of achievement of specific content categories by performance levels was possible. The design was a 2 x 3 treatments by levels design.

In the eleventh grade a comprehensive testing program was instituted. It included unit tests and post treatment tests. The post treatment tests differed in the two years as did the actual treatment. In both years the students received five days instruction in the use of BASIC and then applied their skills to fifty-four settings for computer use in advanced algebra. The settings related to skill development, concept formation or problem solving in algebra. These students were blocked into high and average previous mathematics achievement. The design was a 2 x 2 treatments by levels design.

4. Findings

Seventh Grade. For the first year only one significant treatment effect was observed. It occurred on the Number Systems test and favored the noncomputer group. On the average the noncomputer group out-performed the computer group on all performance measures.

For the second year three significant treatment effects were found. They occurred on the Elementary Number Theory test, the Contemporary Mathematics test and the Thought Problems test. All differences favored the computer group as did the average performances on the other instruments. At the end of the second year the computer group showed greater success on "concept" and "problem" items than did the noncomputer group.

Eleventh Grade. For the first year the computer group out-performed the noncomputer group on one of seven measures (Contemporary Mathematics test). For the second year, similarly, the computer group out-performed the noncomputer group on one of eight tests (Quadratic Functions). In 13 of 15 measures of achievement the computer group had higher measured performance than did the noncomputer group. There was a tendency for the use of computers to be facilitating for the average group more than for the high group. From examination of test items, it was found that the computer had some facilitating effect in Linear Systems, but had some devilitating effect in Trigonometry and Complex Numbers.

Interpretations

The findings reported in this study tend to suggest that the use of computer programming in regular mathematics classes has a facilitating effect on the learning of some mathematics. At the seventh grade level the average and above average seem to benefit most, even though the low group learned to program. In grade eleven, the average group benefited most. There is, also, at the seventh grade level some indication that the analytic procedures used in preparing programs facilitate analysis of word problems. The authors conclude with recognition of the limitations of their work and suggest that further research is needed to develop a sound basis for computer use in schools.

Abstractor's Notes

It should be remembered, as the authors did, that the data were collected during a period in which the materials used by the students were being developed. Thus the inconsistencies seen across years may be explained.

Even so, what is most appealing about the work is that it was carried out for a substantial period, two years. More such long term work is needed in many areas.

It would have been beneficial to this reader to see data on attitudes toward mathematics, computers and programming, and problem solving as well as the achievement data. Also, data on student performance in programming would be valuable for if one expects programming to be useful, the student must be able to use the skill.

Arthur F. Coxford
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EJ 036 824 310 PS 501 026
CHILDREN'S UNDERSTANDING OF PROBABILITY CONCEPTS. Hoemann, Harry W.; Ross, Bruce M., Child Development, v.42 n1, pp. 221-236, Mar. 1971.
Descriptors--*Probability, *Cognitive Development, *Concept Formation; *Task Performance, Age Differences, Deaf Children, [Piaget, Inhelder]

Expanded Abstract and Analysis Prepared Especially for I.M.E. by William E. Geeslin, University of New Hampshire.

1. Purpose

The purpose of this investigation was to ascertain the age at which children acquire some understanding of probability concepts. Of particular importance were: 1) whether children acquired the probability concept prior to Piaget's stage of concrete operations; and 2) the use of tasks which forced children to rely on probability judgments in addition to proportionality judgments.

2. Rationale

Recent American studies have indicated that children show some understanding of probability concepts prior to the stage of concrete operations. However, Piaget and Inhelder claim that a child must be in the concrete operations stage prior to attaining consistent knowledge of probability concepts. Hoemann and Ross feel that at least part of this contradiction is due to other variables being confounded with the probability knowledge variable. In particular one should design experimental tasks which measure knowledge of probability separately from knowledge of proportion.

3. Research Design and Procedure

The study involved four separate but closely related experiments. Subjects in Experiments 1-3 were predominantly middle class students making normal progress in school. In Experiment 1, eight groups of 20 Ss (10 boys and 10 girls) were required to choose one of a pair of paper disks placed before them. Each disk was comprised of black and white wedges. Two groups were selected at each of four mean age levels: 4 years - 7 months; 6 years; 7 years - 5 months; and 10 years - 6 months. At each age level one group received probability instructions and one group received proportionality instructions.

Probability instructions were: "I want you to look at the two spinners very carefully and show me which one you will spin to make the pointer point to black (white)." Proportionality instructions were: "I want you to look at these two circles very carefully and show which circle has the most black (white)." Ss given probability instructions were allowed to spin the chosen spinner and a favorable outcome was acknowledged even when the incorrect spinner was chosen. Ss given proportionality instructions were not told if they chose the correct disk. The difference between the probabilities (proportions) of the desired color between disks in each pair was considered a variable also (odds difference variable).

Seven groups of 20 Ss (10 boys, 10 girls) within six months of mean ages 4-3, 5-3, 6-2, 7-2, 8-2, 12-2, and 13-2 were tested in Experiment 2. Experiment 2 was similar to Experiment 1 except only one spinner was used in each trial. All groups performed under probability instructions and then the five younger groups performed under proportionality instructions. Probability instructions were: "I want you to spin this pointer, but first show me what color it will point to when it stops." Favorable outcomes were reinforced by the experimenter. In proportionality trials Ss were to point to the majority color and no reinforcement was used.

Experiment 3 included a two disk task just as Experiment 1 except Ss were required to compare different rather than the same colors on the two disks. Only probability instructions were used. Two groups of 13 (8 boys, 5 girls) seven year old Ss were asked on each trial: "Will you spin here for black or here for white?" One group was administered this double spinner task and the other group performed a single spinner task as in Experiment 2.

In Experiment 4 three groups of Ss were used: 20 lower middle class Ss with average age 7 years - 8 months; 17 middle class Ss with mean age 11-7; and 14 deaf Ss with mean age 11-2. Two trasnparent 1-gallon glass jars were used instead of disks. Pink and green table tennis balls were placed in each jar. Instructions were: "Would you rather pick a green ball in this jar or a pink ball in this one?" After S chose a jar, the jar was covered and he was allowed to draw a ball. Favorable draws were reinforced regardless of which jar was selected.

4. Findings

In Experiment 1 the differences between combined proportionality and probability groups were not significant at any age. Under both instructions accuracy in performance increased when odds differences between the two disks increased. The only significant difference between age groups occurred between the 4½ years and 6 years proportionality groups. These same two groups performed significantly different across the odds differences variable. A supplementary experiment on three groups of 20 Ss at age levels 4-6, 6-6, and 8-6 indicated that using probability instructions and then proportionality instructions on all Ss gave the same results as the use of independent instruction groups.

In Experiment 2 there were significantly more errors in the probability results as compared to the proportionality results at each age from 4 through 8. Age 4 Ss did not perform significantly better than chance under probability instructions. The only significant age difference under probability instructions was between 8 and 12. Smaller odds differences produced fewer correct responses with probability instructions. However, only at age 7 were these differences significant.

Experiment 3 results were similar to Experiment 2 results. No significant differences between age groups occurred in Experiment 4. However, results between 7 year olds in this experiment matched the other experiments closely. Deaf children performed similar to hearing children. Consistently higher performance of older children as compared to younger children was noted.

5. Interpretations

It is easier for children to choose between two odds ratios the one with the more likely odds than to choose the more likely event in a single-odds ratio. That is, under probability instructions the single spinner task is more difficult than the two spinner task. Thus, Experiment 2 forced S to use probability concepts as well as proportionality judgments while in Experiment 1 S may have relied only on proportionality judgments. Piaget and Inhelder explain that the one spinner task forces S to use fractional comparisons. The modified double spinner task in Experiment 3 was designed to force S to use fractional comparisons and results of this task were comparable to the single spinner task. Experiment 4 indicated the discrete object task was equivalent to the Experiment 3 double spinner task. It was concluded that tasks in both Experiments 3 and 4 forced S to apply probability concepts.

Choosing the more favorable odds need not require the use of probability concepts. Children may be successful in certain tasks by relying only on proportionality judgments, particularly in tasks where direct magnitude comparisons are possible. One difficulty in using the above chance performance as an indicator of probability knowledge is that these tasks are too easy for children. Not all tasks that are nominally probability tasks force children to make probability judgments and thus past research is questionable. In contrast to past studies, deaf children performed as well as other children. This study supported the process explanation of Piaget and Inhelder concerning the difference in difficulty between two-array and single array predictions. Hoemann and Ross concur with Piaget's view concerning the onset of probability knowledge, but this view depends on what is considered a probability concept. For example, magnitude comparison is mastered at a very early age and if this is considered a probability concept than probability knowledge occurs prior to the concrete operations stage.

Abstractor's Notes

As noted by Hoemann and Ross, the onset of probability knowledge depends partly on definition of such knowledge. Additionally, changing the tasks designed to require probability concepts may produce different results. The experiments reported are a nice example of attacking a complicated question through a series of systematic studies. A danger with this procedure is that a faulty inference in an early study may invalidate later studies. Hoemann and Ross alleviate this difficulty partly by continually comparing results between experiments. However, most of the experiments should be replicated.

The question of the onset of probability concepts was left open due to the non-use of younger Ss in the later experiments. In fact, no experiment contained an independent test of whether or not Ss were in the concrete operations stage. This would seem to be particularly crucial in the 6-8 years age groups. The various analyses were questionable due to use of percentages, difference scores, and lack of multiple comparison techniques. Although sex seemed an important variable in selecting Ss no data analysis by (between) sexes was reported.

Finally, as with most concept formation studies, the definition of the concept appears to be a major factor in the study. Hoemann and Ross demonstrate that changing the task (instructions) changes performance, but they do little to justify or state clearly the term "probability concept." "Make the spinner point to black" is not a mathematically correct probability statement. One can only determine which outcome is more likely. Reinforcing a favorable outcome even though an incorrect disk is chosen may confuse the subjects or "mis-educate" them. This notion might be compared to the Las Vegas gambler. If the gambler rationally followed the laws of probability he would not participate in most games. Are we to conclude that gamblers are not in the concrete operations stage and do not have probability knowledge? Admittedly this is stretching the point, but dealing with probability may introduce additional difficulties to an already complex problem of human development. Thus future investigations might consider more variables and controls, particularly those of reinforcement, training, and motivation.

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EJ 045 553 110 SE 504 128

AN EVALUATION OF A SHORT-TERM IN-SERVICE MATHEMATICS PROGRAM FOR ELEMENTARY SCHOOL TEACHERS. Hunkler, Richard, School Science and Mathematics, v.71 n7, pp. 650-654, Oct. 1971.

Descriptors--*Elementary School Teachers, *Inservice Teacher Education, *Mathematics Education, *Program Evaluation, Modern Mathematics

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Edward J. Davis, University of Georgia.

1. Purpose

Two null-hypotheses were tested for each of the three academic years beginning 1965-66.

1) "There are no differences between the arithmetic concepts scores of those sixth grade pupils whose teachers have not completed a short term in-service mathematics program and those pupils whose teachers have completed one or more short term in-service programs.

2) There are no differences between the arithmetic problem solving scores of those sixth grade pupils whose teachers have not completed a short term in-service mathematics program and those pupils whose teachers have completed one or more short term in-service programs."

2. Rationale

The author points to studies indicating an increase in mathematical knowledge on the part of teachers completing in-service workshops and to research reporting no significant difference in achievement between students of teachers who were, and those who were not, in-service participants. It was conjectured this discrepancy might be explained if certain variables could be controlled. Hunkler felt teacher variables: 1) semester hours of mathematics, 2) years of college preparatory mathematics, 3) teaching experience, and 4) recency of degree could contribute to pupil achievement and mask the effort of in-service training. In addition, to give additional information, pupils with one, two, and three years of instruction from a modern mathematics textbook were used as subjects.

3. Research Design and Procedure

The population included 148 sixth grade teachers and their students for 1965-66, 1966-67 and 144 of these teachers for 1967-68. There were approximately 4,000 students for the first two years and nearly 3,000 the third. All were drawn from a large metropolitan area.

Two groups were constructed. One being teachers (and their pupils) having completed one or more inservice courses in teaching modern mathematics, and those teachers (and their pupils) who had not. In-service courses, consisting of five 90 minute sessions, had been offered yearly on a voluntary basis since 1962. Students' arithmetic concepts and problem solving scores on the Iowa Test of Basic Skills were the dependent variables. The independent variable was the number (n) of in-service courses ($n = 0$, or $n \geq 1$) taken by the teachers.

> "Differences in arithmetic concepts and problem solving scores of the two groups for each of the years was determined by analysis of covariance with the teacher variables of 1) semester hours of college mathematics, 2) years of college preparatory mathematics, 3) years of teaching experience, and 4) recency of any college degree used as concomitant variables. The student's IQ, as measured by the Otis Quick Scoring Mental Ability Tests, was also used as a concomitant variable in an attempt to compensate for the differences in the student's scholastic ability."

4. Findings

For 1965-66, the first null hypothesis was rejected ($p < .05$). Students whose teachers had completed one or more in-service courses had a mean arithmetic concept score of 77.80 and their counterparts a mean of 76.96.

For 1966-67 and 1967-68 the first null hypothesis was rejected at the .05 and .10 levels. However, this time it was students of teachers not having an in-service course that had the higher means (73.02 vs. 72.32 and 73.52 vs. 73.18).

The second null hypothesis was not rejected for any of the three years.

5. Interpretations

The following conclusions were drawn:

1) "Completing one or more short-term in-service mathematics programs has a positive effect on the arithmetic concept scores of the teachers' pupils who have had only one year of instruction using a modern mathematics textbook.

2) Completing one or more short-term in-service mathematics programs has a slightly negative effect on the arithmetic concept scores of the teachers' pupils who have had two or three years of instruction using a modern mathematics textbook.

3) Completing one or more short-term in-service mathematics programs has no apparent effect on the arithmetic problem scores of the teachers' pupils."

Abstractor's Notes

It is quite possible the four teacher variables cited and statistically controlled could affect student achievement. The same can be said for student I.Q. It was a step in the right direction to employ an analysis of covariance in this respect. However, it is also likely that other teacher and student variables affected pupil performance. Consideration should also have been given to the achievement of teachers in mathematics and in the in-service courses (if this was available), and more importantly to students' previous performance in mathematical computation and problem solving. The effect of the latter has been well documented.

Perhaps data gathered from including the additional variables just cited would help in explaining the puzzling statistical difference in the results between the first, and the second and third years, on arithmetic concept scores. On this result, however, one should not lose sight of the small difference in magnitude of the reported means, and not be overly impressed with statistical significance at the .05 level.

The title of the study indicates the shortness of the inservice program. It may be presumptuous to expect a great deal from five 90 minute sessions. It would help to know something about the nature of these sessions. Were they all lecture? Were any demonstration lessons given or any laboratory sessions held? Did teachers try out ideas and report back on them? The only description of the in-service course was as follows:

> "The short-term in-service mathematics program evaluated in the study was a professional growth course in modern mathematics for grades K-6. The course was sponsored by the school district used in the study, and involved five ninety-minute sessions. The course was designed to meet the following two objectives: 1) acquaint teachers with additional ways to help children discover new approaches toward the mastery of computational skills, number systems and algebraic systems, and 2) help teachers become more familiar with teaching aids available in modern mathematics."

I have some idea of what meeting objective #2 entails, but am confused as to how one helps children discover mastery of computational skills.

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EJ 046 254 310 PS 501 399
THE LEARNING AND TRANSFER OF DOUBLE-CLASSIFICATION SKILLS: A REPLICATION AND EXTENSION. Jacobs, Paul I.; Vandeventer, Mary, Journal of Experimental Child Psychology, v.12 n2, pp. 240-257, Oct. 1971.

Descriptors--*Learning, *Transfer of Training, *Classification, Grade 1, [*Double Classification Skills]

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Frank K. Lester, Indiana University.

1. Purpose

This study attempted to assess whether double-classification training with color and shape relations produced transfer throughout a class of all possible pairings of nine other relations. Subsidiary purposes were to evaluate the effects of an extended training procedure and to compare the effectiveness of trainers with different backgrounds.

2. Rationale

Double-classification problems form the basis of many intelligence tests and are important in Piagetian theory. There is evidence that first grade children can learn the skill of double-classification with color and shape relationships in a relatively short period of time. It is not known if this skill on double-classification is relation specific or if it transfers to tasks involving other relations. If transfer does occur, there may be reason to believe that first-graders may be able to arrive at "operational" solutions to double-classification problems rather than being limited to "graphic" or perceptual solutions as Piaget suggests.

3. Research Design and Procedure

Two experiments were conducted. Experiment 1 was concerned with certain methodological issues related to training procedures (e.g., the magnitude of practice effects) and procided a basis for determining the order of items on the pre- and posttests of Experiment 2. In addition, Experiment 1 was considered a "useful tooling-up for the main study."

Experiment 2 sought to determine whether relatively brief training on double-classification tasks involving color and shape relations transfers to a universe containing all possible pairings of nine other relations (viz., size, movement in a plane, addition, shading, number series, added element, flip over, elements of a set, and reversal). In addition, the effects of providing extended training and the effectiveness of trainers with different backgrounds were investigated.

Ss were fifth-seven first graders in three classes of a central New Jersey elementary school. All Ss were individually administered a pretest consisting of twenty items. The items were constructed as follows: a 2x2 or 3x3 matrix of 2-inch square cells was printed on each of twenty sheets of paper. On each sheet the cells contained a painted shape, except for the lower right-hand cell which was empty. The S's task was to determine what belonged in the empty cell. Ss were rank ordered according to pretest score. Among the highest three scores, one was assigned at random to the regular training (RT) group (shape and color relations involved in the tasks), one to the extended training (ET) group (tasks involved more relations than just color and shape), and one to the control (C) group. This procedure was carried out for each of the other ability groups of three Ss. Training began about one month after pretesting. Ss were individually trained until they performed at criterion level or a specific amount of time had elapsed. For the RT group, Ss were guided to discover and verbalize certain attributes of the entries in 2x2 and 3x3 matrices involving the relations color and shape. Ss in the ET group used the regular training tasks plus sorting tasks, supplementary training tasks involving different relations, and tasks requiring the S to build a 3x3 matrix from a 2x2 matrix (build-a-matrix tasks). The day after all training was completed Ss were administered a 60-item matrix posttest and two build-a-matrix tasks. Approximately three months after the posttest a retention test, consisting of the original posttest and Raven's Coloured Progressive Matrices (CPM) was administered to all Ss. Three levels of transfer were defined in terms of the number of relations contained on a posttest item that were not encountered during training. If training was provided for neither of the relations in a posttest item, far transfer was involved; for one of the relations, moderate transfer; for both of the relations, near transfer. A treatment by ability randomized block design was used to analyze the data.

4. Findings

Experiment 1. The authors concluded ". . . that such factors as practice effects due to lengthy testing without knowledge of results, differences among relations in matrices, and size of matrix were all of minor importance relative to the known magnitude of training effects."

Experiment 2. The treatment by ability block ANOVA for posttest scores showed a significant treatment effect ($p < .01$) and a significant effect for ability blocks ($p < .01$). Analysis of retention test scores indicated that the increments due to training revealed on the posttest were maintained on the retention test ($p < .01$); there was also significant retention for ability blocks ($p < .05$). The analysis of the levels of transfer reached showed the results given in the table below:

Type of Transfer

Groups	Near	Moderate	Far
RT vs. C*	$p < .01$	$p < .01$	n.s.d.
ET vs. C	$p < .01$	$p < .01$	$p < .01$
ET vs. RT	n.s.d.	$p < .01$	n.s.d.

*The group listed first produced more transfer.

Transfer to the CPM was also assessed. The CPM was administered during the retention testing. A significant main effect for treatment ($p < .05$) was found. Matched group t-tests showed that the only significant difference in performance on the CPM was between groups, ET and C ($p < .02$).

No significant differences were found between groups trained by different Es.

5. Interpretations

Well-defined training procedures can produce transfer throughout a well-defined universe. More specifically, regular training does transfer to a broad range of tasks involving relations different from those included in the training. When the training is extended to include practice on a greater variety of relations than just color and shape even greater transfer occurs. The fact that transfer was obtained to a broad range of relations suggests that operational solutions rather than "graphic" (perceptual) solutions had been learned by the Ss. The fact that there was no significant difference between groups with different trainers supports the belief that treatment variables are more important than differences in trainers.

Abstractor's Notes

The experiments reported in this study are part of a series of studies which have been oonducted by the authors. The importance of research into the learning and transfer of double-classification skills has been well established in Piagetian research and is clearly evidenced by the occurrence of double-classification tasks in many intelligence tests. It is divvidult to provide critical comments which are accurate without becoming familiar with the rest of the research the authors have conducted in this area. The difficulty is compounded by the lack of detail given in the report on training procedures and absence of examples of both training and testing tasks. The authors are to be commended for their attempts to use the research design most appropriate to answer the research questions. They also made a serious effort to control extraneous and confounding variables. However, there are several issues concerning their methodology and the conclusions drawn which are cause for concern:

1. The authors conclude from the results of Experiment 1 that differences among relations in matrices, and size of matrix were of minor importance relative to the known magnitude of training effects. This statement is inconsistent with the statistical analysis which showed the color matrices to be significantly easier than shape matrices and 3x3 matrices significantly easier than 2x2 matrices.

2. The authors attempt to "explain away" the fact that color matrices were easier than shape matrices by noting that the "mean difference between color matrices and shape matrices, when reduced to a 4-item base, was only 0.08 items correct." This abstractor wonders if the authors realize that no matter what scoring "base" is used, the mean difference will still be significant.

3. The claim is made that the significant main effect for ability blocks in Experiment 2 indicates that Ss with higher pretest scores had higher posttest scores. This claim is totally unjustified. There is no indication that any post hoc multiple comparisons tests were run. Consequently, there is no reason to believe Ss who scored higher on the pretest also scored higher on the posttest.

4. A randomized block design was chosen in order to minimize individual differences among Ss within a block and to control variability among Ss which could obscure treatment effects. The choice of this design seems appropriate; however, there is one caution. Randomized block designs are powerful only if the variation among Ss within blocks is much smaller than the variation among blocks. There is some reason to suspect that this may not have been the case.

The studies reported in this article were carefully conceived and thoughtfully conducted. The criticisms raised should not be interpreted to mean that the studies were not well done but rather to point out some limitations which should be considered in interpreting the results.

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EJ 044 701 310 PS 501 303
THE EFFECTS OF VISUALLY REPRESENTED CUES ON LEARNING OF LINEAR FUNCTION RULES. Lee, Seong-Soo, Journal of Experimental Child Psychology, v.12 n1, pp. 129-145, Aug. 1971.

Descriptors--*Visual Stimuli, *Cues, *Learning, Training, Grade 4

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Larry Sowder, Northern Illinois University.

1. Purpose

"Can the acquisition of simple linear function rules be facilitated by means of visually represented cues?... Can training on the simpler rules (S=aF and S=F+b) facilitate the acquisition of a complex one (S=aF+b)...?"

2. Rationale

Providing a concrete referent on which to base the rules should enable representatives of the referent to serve as mediators for vivid mental images and thus enhance performance. A Gagne-type analysis would suggest that work on the simpler rules should precede work on the complex one.

3. Research Design and Procedure

The concrete referent used was a balance scale and weights. The learning tasks (S=4F, S=F+5, S=3F+2) could be interpreted in the context of a weight (F) and a scale reading (S).

Two levels of weight (picture of weights or no picture present), 3 levels of context (verbal alone, verbal plus graph, verbal plus picture of balance scale), and 2 levels of ability (top half, bottom half of subjects, based on a 25-item arithmetic test) provided a 2x3x2 factorial design. A control group was also used in addition to the 6 weight x context treatment groups.

The 70 Ss came from a fourth-grade in a single school. The 7 Ss in each stratum (based on the arithmetic test) were randomly assigned to treatment or control groups. In individually administered sessions, each S first became familiar with the weighing apparatus and language; S was then put in an experimental cubicle without the balance and weights present, but--depending on S's treatment--with (1) a graph, a picture of the balance, or a blank paper, and (2) a drawing of weights or another blank paper.

After warm-up tasks, six numerical instances were presented, S being given an F value and asked to predict the scale value, including as part of his response pointing to weights and/or balance, as appropriate, and recording his prediction by giving an equation. Reinforcement of responses was provided by lights. After these 6 instances, and after every subsequent 3 such numerical instances, 2 test instances were given, one numerical and the other general (e.g., write an equation relating F and S). Criterion was met when S gave 7 consecutive correct responses. For the S=3F+2 rule, all Ss operated under a verbal context-no weight condition. Performance measures of time to criterion, number of numerical instances, and total number of errors were analyzed by a multivariate ANOVA.

4. Findings

For the S = 4F task: N.s.d. for main effects but the (statistical) combination of the graph and picture with the weight picture was effective ($p < .07$).

For the S = F + 5 task: Weight and context main effects were significantly different ($p < .04$ and $p < .001$, respectively). Graph and picture vs verbal favored the former ($p < .02$), and picture vs graph favored picture ($p < .02$).

For the S = 3F + 2 task (transfer): Treatment groups performed significantly different from the control groups ($p < .001$), but did not differ amongst themselves. The top ability groups performed better.

5. Interpretations

"...visually represented cues are effective variables for the acquisition of a rule rather than for transfer." The interdependence of the weight and context cues is suggested by the results for the S = 4F task. With more experience, the cues can perhaps operate effectively alone, as with the S = F + 5 task. Although training on the simpler tasks clearly facilitates performance on the S = 3F + 2 task, the lack of differences among treatment groups on the task might be due to (a) the verbal context being sufficient after experience, (b) Ss' "topping out" on the performance measures, or (c) forcing Ss accustomed to cues to work without them having a negative effect.

The pointing responses asked for may have helped Ss make maximal use of the cues, since E's earlier work without such pointing gave no cue effects.

Abstractor's Notes

1. That care must be taken to insure that Ss are undergoing the presumed treatment is a good lesson; here, having them point seemed to give an involvement that was perhaps missing in the earlier study.

2. The results may be dependent on the constants chosen. The abstractor's experience indicates that S = 4F would be harder for fourth graders than S = F + 5 and hence would most profit from the strongest cueing combinations.

3. The uniformly strong performance on S = 3F + 2 was surprising. Might E's protocol have included some hints? Or might the particular sequence of instances deserve credit?

4. The author commendably has given an elaborate rationale for the experiment and a careful discussion of the results. In examining the performance on S = 3F + 2, however, to consider anything other than "topping out" in light of the data seems unnecessary.

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EJ 052 092 270 SE 504 913
EFFECTS OF ARITHMETIC HOMEWORK UPON THE ATTITUDES AND ACHIEVEMENT OF FOURTH, FIFTH AND SIXTH GRADE PUPILS. Maertens, Norbert; Johnston, James, School Science and Mathematics, v.72 n2, pp. 117-126, Feb. 1972.

Descriptors--*Arithmetic, *Elementary School Students, *Feedback, *Homework, *Parent Participation, Achievement, Mathematics Education, Student Attitudes

Expanded Abstract and Analysis Prepared Especially for I.M.E. by John C. Peterson, Eastern Illinois University.

1. Purpose

This study had two purposes:

1. To determine the effects of arithmetic homework involving planned parental participation upon arithmetic computation, problem solving performance, and attitudes toward arithmetic, homework, and school.

2. To determine whether children receiving per-problem knowledge of results from their parents differed significantly in arithmetic performance or attitudes from those receiving knowledge of results upon completion of their total assignment.

2. Rationale

The effectiveness of arithmetic homework in improving academic performance in elementary school mathematics has been disappointing. Four cited studies found no significant improvement in performance among those groups which received arithmetic homework as opposed to no-homework groups. One study found that groups receiving arithmetic homework performed significantly better than a group which received no homework.

Homework has often been a source of friction between teachers and parents. Attempts by teachers to enforce completion of homework assignments have often resulted in strained relationships between teacher and child as well as between teacher and parents.

3. Research Design and Procedure

Because this study required parental involvement, Ss were selected from those whose parents returned letters indicating they would be willing to participate in the experiment. Students from this group were randomly assigned to one of three homework treatments. At the beginning of the study the sample included 146 fourth grade, 137 fifth grade, and 134 sixth grade students. (Note: Sample sizes given in Table 1 exceed these figures in some areas. No explanation for these discrepancies is given.) These samples were reduced for the usual attrition reasons plus the requirements that, for inclusion, a S could miss no more than one weekly test or had to take both the pre- and post-test.

There were three homework treatments: (1) No Homework, where Ss were given no arithmetic homework and no additional homework in other subject areas; (2) Per Problem Knowledge of Results, where Ss received two story problems and 8-10 computational exercises as homework each Monday through Thursday. As a student completed each homework exercise one of his/her parents would give the correct answer to the exercise; (3) Delayed Knowledge of Results, Ss received the same homework exercises as students in Group 2 except that parents did not read the correct answers to the exercises until the entire homework assignment was completed.

Prior to beginning the experiment each S was given an attitude test over children's attitudes toward school, arithmetic, and homework; and an arithmetic test over the material in the previous year's textbook. A weekly achievement test consisting of 15 computational and 5 story problems was given each Friday. These weekly tests were designed for power rather than speed. Weekly test scores used in the analyses were derived by using the sum of the six weekly tests for each S. Post attitude measures were given on Monday following the completion of the sixth week. The arithmetic post-test, designed to measure computation and problem solving skills, was given the following Tuesday. The computation test consisted of 35 items and the problem solving test consisted of 20 story problems.

Two planned orthogonal comparisons were performed to test for significant differences between, (1) the means of the homework and no-homework groups, and (2) the means of the per-problem knowledge of results and the delayed knowledge of results groups.

4. Findings

1. There were no significant differences between treatment means on the pre-test.

2. Group means for weekly quizzes were significantly different between homework and no-homework groups on both the computation and problem solving tests for grades 4 and 5. There were no significant differences between the homework and no-homework groups for grade 6. Differences between the Per-Problem and Delayed groups were not significant at any grade level. All differences favored the homework groups over the no-homework groups.

3. Post-test means were significantly different between the homework and no-homework groups on both the computation and problem solving tests for all three grades. There were no significant differences on either test between the Per-Problem and Delayed groups at any grade level. All differences again favored the homework groups over the no-homework groups.

4. On the attitude test, no significant differences were found on any of the orthogonal comparisons among treatment means.

5. Interpretations

Results indicate that homework combined with parental involvement as used in this study does have a significant effect upon both computation and problem solving performances. Whether the parent is involved in giving immediate knowledge of results or end-of-assignment knowledge of results seems to make no difference. Involvement of the parents resulted in pupils consistently completing the assignments.

Although no significant results were obtained from attitude measures a general decline can be noted in mean attitude scores for all groups at all grade levels from the time the pre-test was administered at the beginning of the school year until the post-test was given six weeks later.

Abstractor's Notes

This is the type of study that should interest many teachers since it seems to have some immediate usefulness to the classroom. Many parents want to be more aware of what their children are doing in school and, whenever possible, to assist them in their work. Maertens and Johnston have shown one way in which this can be done.

Both of the groups that received homework differed from the no-homework group in that they, (1) had homework, (2) had parental feedback, and (3) completed their assignments. Since the two groups with homework scored significantly higher on the computation and problem solving post-tests it would be useful to know which of these factors, either singly or in combination, accounted for these differences.

The researchers could have conducted several additional orthogonal comparisons. They examined whether there were any differences between (1) homework groups and no-homework groups, and (2) per-problem groups and delayed groups. They should have also examined whether there were any significant differences between, (1) per-problem groups and no-homework groups, and (2) delayed groups and no-homework groups. It is possible that one of the homework groups might have scored significantly higher than the no-homework group while the other homework group did not.

Finally, the data in Table 1 on Sample Sizes is inconsistent with the data in the text. In the text the authors state that at the beginning of the study there were 146, 137, and 134 fourth, fifth, and sixth graders, respectively. This was before attrition reduced these samples for the final analyses. Yet, Table 1 indicated that 153 fourth grade students took the attitude test; an increase of seven students. The fifth grade total for the weekly quizzes in Table 1 should be 143 rather than 153 as given. Even when correctly added this is greater than the 137 fifth grade students reported to be in the sample. The sixth grade figures in Table 1 for the attitude, pre- and post-arithmetic, and weekly tests are 151, 139, and 137, respectively. All of these figures exceed the stated sample size of 134.

In general this study seems to have been well designed. I would like to see investigations conducted into the questions this study did not answer.

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EJ 038 323. 340 SE 503 385
THE EFFECT OF ACTIVITY-ORIENTED INSTRUCTION UPON ORIGINAL LEARNING, TRANSFER, AND RETENTION. Moody, William B.; And Others, Journal for Research in Mathematics Education, v.2 n3, pp. 207-212, May 1971.
Descriptors--*Activity Learning, *Grade 3, *Multiplication, *Research, Achievement Gains, Mathematics Instruction, Retention Studies, Transfer of Training

Expanded Abstract and Analysis Prepared Especially for I.M.E. by James M. Sherrill, University of British Columbia.

1. Purpose

"...to examine the efficacy of activity-oriented instruction in the learning of multiplication." To achieve the purpose, three statistical hypotheses were tested: There is no difference between activity-oriented and conventionally instructed subjects in a) original learning (OL) of multiplication facts, b) transfer of learned multiplication facts, and c) retention of learned multiplication facts.

2. Rationale

The authors, via Kieren's RER article on activity learning, point out that there has been a great deal of discussion concerning the effects of activity-oriented instruction on learning, but very little empirical evidence. The authors then state, "If activity-oriented instruction is more effective than more conventional forms of instruction, then it should result in either higher original learning, higher transfer, or higher retention of the instructional content."

3. Research Design and Procedure

Ninety third grade students who had received no formal instruction in multiplication were randomly assigned to four treatments. The treatments were the a) activity-oriented treatment (A) which consisted of multiplication instruction starting each day with a class activity in which all subjects manipulated the instructional materials, b) rote treatment (R) which consisted of multiplication instruction (without activity suggestions and word problem instruction) with emphasis upon memorization of basic facts and algorithms, c) rote-word problem treatment (RW) which was the same as R with the addition of practice in solving multiplication word problems, and d) control treatment (C) which consisted of instruction in addition. All treatments were presented concurrently for four weeks by the district's mathematics supervisor.

The transfer test (15 multiplication word problems randomly chosen from the pooled multiplication word problems contained in 5 widely used commercial third grade mathematics textbooks, test-retest reliability of 0.80) was administered as a pretest. The computation test (15 computation problems using exactly the same numbers without words found in the transfer test) was administered the last day of instruction. To measure retention the transfer and computation tests were readministered 6 and 8 weeks respectively, after completion of instruction. No multiplication instruction took place during the time interval.

Three orthogonal comparisons between treatment means were performed for each of four sets of scores used to test the three hypotheses: 1) All instructed treatments (A, R, and RW) were contrasted with the non-instructed treatment (C) to ascertain whether learning, transfer, and retention had occurred as a function of instruction; 2) Treatment R was compared to treatment RW to measure the effects of instruction in the solving of word problems; 3) Treatment A was compared to the remaining two instructional treatments (R and RW) to ascertain the differential effects of activity-oriented instruction on original learning, transfer, and retention.

4. Findings

Of the 12 contrasts the only statistically significant finding was that original learning (using the first administration of the computation test as the criterion measure) occurred as a function of instruction.

5. Interpretations

Generalization of the results is limited by the small sample size, the atypical subjects (mean IQ = 95), and the low degree of original learning. The highest mean for original learning was 5.91 out of 15; the highest posttest mean for transfer was 3.91 out of 15.

If further research on the effect of activity-oriented instruction replicates the finding presented, then some theoretical "appearance saving" may be called for by those systems which predict the superiority of activity learning.

Abstractor's Notes

The authors present a well designed study and article and should be commended for their efforts. There are, however, a few points that need to be included in this section.

Though the reliability coefficient for the computation test seems fine, 0.79 is rather low for a computation test in arithmetic. The abstractor thoroughly agrees with the authors when they state that the very low degree of learning and transfer that took place is "...a fact which may explain the failure of all the treatments to effect transfer of learned computational skill to word problems involving identical computational requirements."

Since all treatments received instruction for the same amount of time and the A group did not score higher than the R group, one asks if that result isn't because the R group had practice with many, many more multiplication problems than the A group. To be honest, however, if the A and the R groups had the same number of problems and the A group scored higher, I probably would be writing, "Of course, the A group had more time." The difficulty is one that stays with us throughout this type of research.

Since abstractors are allowed the luxury of hindsight, the study would probably have been greatly improved if the instructional material had been pilot tested and revised to be sure that higher degree of learning would take place.

Finally, it is interesting to note that the control group, which received no multiplication instruction at all, increased their mean score almost 50% between the posttest and retention test of transfer, the greatest absolute gain and percentage gain for all groups.

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EJ 049 117 290 PS 501 470
YOUNG CHILDREN'S COMPREHENSION OF LOGICAL CONNECTIVES. Suppes, Patrick; Feldman, Shirley, Journal of Experimental Child Psychology, v.12 n3, pp. 304-317, Dec. 1971.
Descriptors--*Language Development, *Kindergarten Children, *Listening Comprehension, Age Differences, Sex Differences, Socioeconomic Status [Logical Connectives]

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Alan R. Osborne, The Ohio State University.

1. Purpose

The purpose of this study was to observe how well young children comprehend the logical connectives of conjunction, disjunction, negation and exclusive-or. In addition, the effect of different idiomatic expressions of the connectives was observed.

2. Rationale

Several studies have established that children use the language of logic and are capable of logical reasoning. However, few studies have explored the extent of the child's comprehension of these connectives or the impact of the particular idiomatic settings of this language use. Thus, there is a need for more detailed information about children's "linguistic habits and competence" in order to develop a theory about children's behavior and changes in that behavior relative to age.

3. Research Design and Procedure

Two experiments were performed, the second apparently an outgrowth of a need for more precision revealed in the first. An interview formed the base for each experiment. The child was given a set of 18 blocks varying on two attributes, color (red, black or green) and shape (star, square or circle). Each child was given an oral command by the interviewer to "give me" blocks according to a description of the set in terms of attributes and connectives.

For experiment 1, the following twelve commands indicate the range of the idiomatic settings:

(1) Give me the green stars.
(2) Give me the red things and the square things.
(3) Give me the things that are black, but not round.
(4) Give me all the red things, and then everything else, but not the stars.
(5) Give me all the things that are black and square.

(6) Give me the green things, or, the round things.
(7) Give me the stars that are red.
(8) Give me the things that are black and not square.
(9) Give me the things that are green, and then everything else but not the stars.
(10) Give me the black things that are round.
(11) Give me the things that are green or square.
(12) Give me the things that are not round but are red.

Seven commands tested conjunction, three involving negation. Disjunction was tested by commands 2, 4, 9, 11. The interviewer checked prior to the commands to see if the Ss could identify the attributes.

Performance as a function of the types of logical connectives and of idioms was examined in a within-subject design. A 2x2x2 factorial design examined between-subjects effects of age, sex and SES. Five three-way ANOVA were made on the total score, conjunction, disjunction, negation and exclusive-or command responses. A regression model was generated in terms of experimenter identified factors of C_i, connective factors, and I_i, idiomatic factors. Sixty-four subjects were selected from a kindergarten and from a headstart preschool in such a manner as to assure equal n in each cell.

The second experiment was based upon comparable interview data. The intent of the second experiment was to provide more refined information concerning the idiomatic setting on children's comprehension of logical connectives. A different set of subjects, 112 children between 4.6 and 6.0 years of age, were divided into 4 groups with age and sex equated across groups. The order of the commands was different for each group. Type connective and type of idiom were within-subject variables and the order of commands was a between-subject variable. Three idiomatic forms were used:

(1) Give me the things that are X and/or Y.
(2) Give me the X things and/or the Y things.
(3) Give me the X and/or Y things.

There were 6 disjunction commands, 4 conjunction commands and 2 exclusive-or commands. Four different orders of administering the commands were used. Again, a regression model provided a means of comparing observe- and predicted error rates per each item.

4. Findings

Experiment 1: SES was a significant variable in 4 of the 5 analyses with children of disadvantaged backgrounds making fewer correct responses. Age was a significant factor in performance on conjunction and negation connectives. Sex was not a significant variable. Only one of the 20 possible interactions was significant. The rank order of difficulty of the connectives was conjunction (71% correct), exclusive-or (67%), and disjunction (11%). Disjunctive tasks were significantly more difficult than conjunction or exclusive-or tasks. Negation increased the difficulty of connectives but did not appreciably affect the rank of difficulty of the different connectives. Regression analysis established a predictive equation:

$$P_i = 0.64 - 0.26C \text{ disjunction} + 0.29C \text{ conjunction} - 0.39I \text{ that are} - 0.32I \text{ all.}$$

These weightings yielded a multiple R of 0.991 with a standard error of estimate of 0.0570. Negation did not enter into the regression equation.

Experiment 2: Results indicated the order of presentation of the commands was of negligible impact according to a chi-square test. For the most part, results of the second experiment paralleled the first. Regression analyses yielded an effective prediction equation based upon a two-variable connective model, the variables being disjunction and negation. With the idiomatic expressions standardized in the second experiment, analysis of the connectives alone accounted for 85% of the variance.

5. Interpretations

A large part of the variance in the mean probabilities of the responses of these children was accounted for by examining the particular connectives used and, also, the idiomatic expression of these connectives. The first experiment did not indicate negation was a major factor in accounting for children's performance where as the second experiment did. This was ascribed to a "considerable dependence between negation and the idiomatic variables."

The authors conclude that before firm conclusions can be drawn about the developmental character of children's comprehension of logical connectives, more extensive and detailed knowledge about the effect of the language in which the use of the connectives is embedded must be obtained. Careful studies of changes in comprehension should be conducted with particular attention given to the linguistic "exposure" of the child. A deeper understanding of the factors contributing to particular types of errors is needed. Thus, a series of experiments within this domain needs to be conducted.

Abstractor's Notes

The experiment addressed the important problem of studying the effect of different idiomatic contexts on the child's comprehension of logical connectives. The experiment was well designed for the purpose of revealing this effect. The results provide verification of what researchers in the logical thinking of children (and adults) should have expected. The difficulties with the disjunctive connective reported in several different experiments should be expected with English speaking subjects because of the ambiguous character of the "or" connective in ordinary, idiomatic English. Thus, two observations are warranted:

1. Children's use of logical connectives is neither correct nor incorrect but is evidence of their habituated linguistic performance.

2. Researchers in the domain of logical thinking need to have control over and report the idiomatic settings of the tasks of their subjects. That is, they need to be able to describe the idiom of the tasks carefully and precisely.

Further research is needed to describe the activities and events that serve to shape the child's language to the formal language of logic. It is easy, however, to envision a series of studies that examine minutia and variants of different idiomatic expressions for logic that ignore some of the larger questions of how children become logical in their thinking.

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EJ 046 337 340 SE 504 127
THE USE OF THE SEMANTIC DIFFERENTIAL IN MEASURING ATTITUDES OF ELEMENTARY SCHOOL CHILDREN TOWARD MATHEMATICS. Scharf, Eugenia S, School Science and Mathematics, v.71 n7, pp. 641-649, Oct. 1971.
Descriptors--*Elementary School Students, *Evaluation, *Mathematics, *Mathematics Instruments, *Student Attitudes, (IPI Mathematics Program)

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Lewis R. Aiken, Sacred Heart College

1. Purpose

The author maintains that children possess stable, measurable attitudes toward mathematics and that these attitudes affect their achievement. A search of the literature, however, revealed few attitude-measuring instruments appropriate for an elementary school population. Essay questions, multiple-choice items, standard scaling-type items, forced-choice and Q-sort techniques are criticized on various grounds. Since the semantic differential technique is simple in format, content, and scoring, opaque regarding appropriateness of response, sensitive to different degrees of attitudinal intensity, and adaptable to correlational, group difference and attitude modification studies, it was decided to develop a semantic differential measure of attitudes toward mathematics in elementary school children. The purpose of the present investigation was to develop such an instrument and then to use it to compare the attitudes of two groups of children--the first exposed to an individualized approach and the second to a conventional classroom approach to mathematics instruction.

2. Rationale

Twenty-three references to previous investigations, including several concerned with attitudes toward mathematics, are cited. A comprehensive review of the literature on mathematics attitudes in elementary school children is not presented.

3. Research Design and Procedure

The semantic differential instrument consisted of three concepts (My Math Class Is, Doing Math Is, Taking a Math Test Is) to be rated on two bipolar adjective scales (Good vs Bad and Happy vs Sad). Each rating scale consisted of five points (very, sort of, neither, sort of, and very). The scales were randomized in both polar directions to avoid "set" responses. Two "lie" items (Being Praised for Doing Something Well Is, Being Scolded for No Reason Is) were included to detect and eliminate the responses of students (10%) who failed to understand the task.

The sample consisted of an unspecified number of fourth, fifth, and sixth grade pupils in four schools using individually prescribed instruction (IPI) and four schools using conventional classroom instruction ("Control"). Of these, usable responses were obtained from 642 IPI and 662 Control pupils. The IPI program, developed at the University of Pittsburgh, differed from the Control condition in that educational objectives were specified in detail, methods and materials were organized to attain these objectives, pupil competence was carefully determined, pupils were evaluated and guided each day, student performance was monitored frequently and the resulting information fed back to pupils and teachers, curriculum and instructional procedures were continually evaluated and strengthened. The IPI pupils had been exposed to this method for three years.

4. Findings

The results of the investigation were analyzed by chi square procedures applied to the six 2 x 3 contingency tables. The two rows of these tables were IPI and Control; the three columns were the Very Positive, Sort of Positive, and a collapsing of the neither, sort of negative, and very negative categories into Not Positive. Significant values of chi square, pointing to more positive attitudes on the part of the IPI groups, were found on the following concepts and scales: My Math Class Is (Good vs Bad); Doing Math Is (Good vs Bad); Taking a Math Test Is (Good vs Bad and Happy vs Sad).

5. Interpretations

The author concludes that more positive attitudes toward math class, toward doing math, and toward taking a math test were shown by the IPI pupils than by the Control pupils. These findings are attributed to the greater pupil mobility, little lecturing or large group instruction, and the greater frequency and less threatening nature of tests in the IPI method. It is concluded that "the experimental treatment did positively affect the attitudes of the pupils toward the learning of mathematics" and "on what specific components...the differences were noted." Furthermore, it is concluded that, because of its objectivity, ease of scoring, and flexibility, the semantic differential can be adapted to a variety of attitudinal studies--both correlational and experimental.

Abstractor's Notes

This investigation can be criticized on various grounds: instrument design, nature of sample, statistical analysis, and interpretation of results. Scharf maintains that the semantic differential technique is better than other methods as a measure of the attitudes of elementary school children. At the time of her writing, Scharf was undoubtedly unaware of the studies of Mastantuono (Dissertation Abstracts International, 1971, 32, 248A) and Evans (Dissertation Abstracts International, 1972, 32, 3086A-3087A). These studies were concerned with a comparison of four arithmetic attitude scales--Dutton-Thurstone, Dutton-Likert, Anttonen-revised Hoyt, and Semantic Differential--administered to large samples of third- and fifth-graders. The Dutton-Likert and Anttonen-revised Hoyt instruments performed best in terms of test-retest reliability and predictive validity. Furthermore, the argument that the semantic-differential is a less obtrusive technique with elementary pupils has never been substantiated to the abstractor's knowledge. At best, the semantic differential is an awkward way to assess attitudes and is replete with shortcomings. Certainly, Scharf's instrument is too brief for even total scores, which are not even reported, to be sufficiently reliable. In any event, no norms, reliability, or validity information (other than the IPI-Control groups comparison) on total or part scores are presented. Finally, in describing the instrument (p. 643) it is not clear how many bipolar adjective scales were actually used in this study--two or more. Osgood's Evaluation, Potency, and Activity dimensions were certainly not all represented.

The nature of the sample is not entirely clear from the description given on page 644. How many students were in the original sample? Did the IPI and Control schools differ initially in characteristics (variables) related to attitude toward mathematics? How many students in each of the three grade groups were included in the total sample? With respect to the administration procedure, when was the questionnaire administered and was it administered to both IPI and Control groups during the same time period?

Concerning the statistical analysis, chi square is an appropriate technique but the reader is shortchanged on the results presented. The results of all chi square analyses--by grade level and total for all three concepts and two bipolar adjective scales--should have been reported. From what is given in the paper, one does not know if the results varied with grade level. Nor is any information given on the relative effectiveness of the instrument at various grade levels.

The most serious difficulty with the interpretation of results is the author's incorrect reference in at least two places (p.646 and 648) to this investigation as an "experiment." Also, the conventional classroom groups are incorrectly labeled as "Control" groups. The careless use of the word "experiment" results in a lapse into cause-effect language to describe the outcomes of what is really a simple correlational study of an "after the fact" sort. In fact, the results could have easily been analyzed in terms of rank-biserial or tau coefficients computed on the contingency tables. Thus, to conclude that such data "can be used to show not only that the experimental treatment did positively affect the attitudes of the pupils toward the learning of mathematics, but in what ways it did so" is patently wrong. The data show nothing of the sort; they show only that the attitudes toward mathematics of the sixth-grade students in the IPI schools tended to be more positive than those of sixth-grade students in the conventional classroom schools. _Post hoc ergo propter hoc_ still represents fallacious reasoning!

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