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ABSTRACT

Twelve research reports related to mathematics education are abstracted and analyzed. Three of the reports deal with aspects of learning theory, three with topics in mathematics instruction (fractions, problem solving, and application orientation), two with aspects of computer assisted instruction, and one each with advanced placement, calculators, mathematics anxiety, and sex differences. Research related to mathematics education which was reported in CIJE and RIE between October and December 1980 is listed. (MP)

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Alderman, D. L.; Winton, S. S.; and Braswell, J. S. ASSESSING BASIC ARITHMETIC SKILLS AND UNDERSTANDING ACROSS CURRICULA: COMPUTER-ASSISTED INSTRUCTION AND COMPENSATORY EDUCATION. Journal of Children's Mathematical Behavior

Abstract prepared for I.M.E. by JOHN G. HARVEY,
University of Wisconsin-Madison.
Comments prepared for I.M.E. by JOHN G. HARVEY and by JAMES E. BIERDEN,
Rhode Island College.

1. Purpose

The study reported is a part of a larger investigation of the effectiveness of computer-assisted instruction (CAI) in compensatory education (Ragosta, Jamison, & Holland, 1978). Specifically, the study examined (a) the extent to which differences in mathematical achievement on paper-and-pencil tests could be attributed to familiarity with the notational conventions of the CAI materials, (b) the frequency of several kinds of errors on curriculum-specific test items, and (c) students' abilities to apply selected mathematical concepts in nontraditional test contexts.

2. Rationale

When the application of an instructional technique or the use of curriculum materials results in improved student achievement, it may be appropriate to examine more closely the treatment effects. In this case, the instructional technique was CAI, and the curriculum materials were those marketed by the Computer Curriculum Corporation (Suppes, Searle, Kanz, & Clinton, 1975). These computer curriculum materials allow students to engage in extensive drill-and-practice of skills in mathematics, reading, and language arts. Preliminary evaluation results suggested that these materials improve student achievement in mathematics (Holland et al., 1978). Thus, this study was initiated to determine if these effects result from improved student learning or result because students become proficient in taking tests or only exhibit learning of the content of exercises presented by the materials.

3. Research Design and Procedures

Subjects

A sample of 251 fifth-grade students in four urban elementary schools had previously been randomly assigned to one of three treatments: 20 minutes of CAI mathematics instruction daily (N - 83) (CAI-M); 10 minutes each of

CAI mathematics and reading/language arts instruction daily (N = 86) (CAI-M/R/L); and 20 minutes of CAI reading/language arts instruction daily (N = 82) (CAI-R/L). These students were the sample for this study when investigating differences in achievement and the frequency of errors. To investigate students' abilities to apply concepts, a sample of 24 students was drawn from each of the CAI-M and CAI-R/L treatment groups; the students in these samples were matched on their classroom teacher, mathematics achievement before the start of treatment (measured by the Iowa Test of Basic Skills), the total amount of time spent using the computer-based materials, and, where possible, sex.

The subjects in the control group were 176 fifth-grade students enrolled in schools which did not provide access to computer-assisted mathematics or reading/language arts instruction. The number of schools and the setting (i.e., urban, suburban, rural) of the control subjects' schools was not described.

Treatments

During both the fourth- and fifth-grade years, the students in the CAI treatment groups had used computer-based drill-and-practice programs. Curriculum-specific and standardized achievement test (California Test of Basic Skills, Form S) scores revealed that students who had been exposed to the CAI materials had statistically significantly higher posttest scores than did students not exposed to those materials.

Study Measures

A curriculum-specific test used in the larger investigation mentioned earlier was revised to eliminate formats and conventions peculiar to the computer; however, ten items were presented in both their original and revised formats. These ten items had shown treatment effects in previous years and contained unusual notational conventions (e.g., 3 X 5 instead of 3 x 5). The two forms of the test used in this study contained all 20 of the items: if an item appeared on one form of the test in its original format first and its revised format later, then on the other form of the test, the item appeared first in its revised format and later in its original format. This test was administered to all of the subjects.

Seven tasks were developed for the individual interviews administered to the 24 pairs of students chosen from the CAI-M and CAI-R/L treatment groups.

These tasks dealt with multiplication basic facts (6 items), place value (4 items), symbols for arithmetic operations (22 items), subtraction with regrouping (3 items), pictorial and concrete representations of multiplication and division (3 items), the associative and distributive properties (6 items), and number line representations of fractions (5 items). These tasks were administered using a form designed to insure that tasks were presented and questions asked in a uniform way.

4. Findings

Notational Differences

The scores of the CAI-M treatment group were compared to the scores of the CAI-R/L treatment group and to those of the control group on the 10 pairs of items presented in both a computer-based and conventional format. On seven of the 10 pairs of items, the CAI-M treatment group mean achievement was higher than that of the CAI-R/L students on both items in those pairs; mean achievement for the CAI-M treatment group was higher than that of the CAI-R/L treatment on one computer-based item and one other conventionally-formatted item.

On eight pairs of items the mean achievement of the CAI-M treatment group was higher than that of the control group on both items in that pair; the CAI-M treatment group had a higher mean achievement than did the control group on one additional computer-based item and one conventionally-formatted item. The differences between the CAI-M and CAI-R/L groups and the CAI-M and control groups were, generally, smaller on the conventionally-formatted items than on the computer-based items.

Error Analyses

The number and kind of errors made by students in the treatment groups and the control group were about the same and had about the same standard deviations. The students in the CAI-M treatment group omitted fewer items on the test than did students in any of the other groups; this group had the highest correct response mean score.

Interview Data

The interview data mean scores are consistent across the two treatment conditions (CAI-M and CAI-R/L), but vary considerably across tasks. These data "fail to convey the behavior of children while performing the interview tasks." As a result, the study report contains a discussion of that behavior as well.

5. Interpretations

Notational Differences

Conventional phrasing of the test items led to a decrease in the percentage of correct responses by the CAI-M treatment group. These students in the CAI-M group still maintained an advantage over both the CAI-R/L and control groups who had no access to the mathematics computer materials. Thus, the positive treatment effects generalize to problems stated in conventional form.

Error Analysis

The responses of students in the CAI-M treatment group showed the same pattern and frequency of errors as did those of students in the CAI-R/L and control groups. Because the CAI-M treatment group omitted fewer items, it seemed that exposure to the computer mathematics materials improved these students' test-taking proficiency. Thus, the drill-and-practice provided may not have remedied students' weaknesses in understanding mathematics, but it did appear to make them more adept and efficient in answering questions.

Interview Results

Students in both the CAI-M and CAI-R/L treatment groups seemed to view numbers and operations as abstract entities and to have few meaningful arithmetic representations. These results do not call the computer materials into question, but challenge a fundamental assumption of drill-and-practice approaches: Students bring to the experience some understanding of the exercise topics. Thus, these results seem to be a strong argument for closer integration of classroom teaching with drill-and-practice materials and a careful analysis of the prerequisites children should have to get maximum benefit from drill-and-practice materials.

Abstractor's Comments (1)

This was a study of very limited scope. It does not attempt to answer many important questions, including "Do the CAI treatments improve learning?" and "If the CAI treatments improve learning, is this improvement as good as, or better than, that caused by other viable instructional techniques?" Hopefully, the major research project mentioned in the study reported will try to answer these and other questions. The results of this study may indicate that students can respond to mathematics problems when those problems are presented in a more conventional format. And it does seem to show that drill-and-practice computer-based materials may not reduce the kind or frequency of errors and that these materials probably will not help students to learn with meaning. However, the abstractor cannot be sure these conclusions are valid for the following reasons.

<u>Sample</u>

How alike were the treatment subjects and the control subjects? Were all of the students in identical or very similar compensatory programs except for the computer treatments? Were the control subjects also students in urban elementary schools? Had the treatment groups and the control group had similar mathematics experiences prior to the beginning of the computer-based treatments?

<u>Treatments</u>

The computer-based experiences do not comprise the entire treatments applied to any group, including the control group. What were the other parts of these treatments? Did all of the schools use the same textbooks, expect students to achieve the same objectives, manage instruction in the same way, and apply the same instructional techniques in the same way, at the same time, and for the same periods of time?

<u>Measures</u>

Exactly what paper-and-pencil test was given to the CAI-M, CAI-M/R/L, CAI-R/L, and control groups? Did it consist of the 10 pairs of items, or were these items embedded in a larger instrument? Were the items presented to the students <u>exactly</u> as shown in the table? (If so, then many students may not have been familiar with the "conventional" format.) How like the notation in the textbooks used by the subjects was the notation of the conventionally-formatted items? How long did students have to complete the paper-and-pencil test and the interview: were the tests speed or power tests? When were the tests administered in relation to the teaching of the skills and concepts tested? The "other errors" category seems very large (about 15% of the responses). Why wasn't a greater effort made to categorize these errors?

Results

Why were data gathered on the CAI-M/R/L and never used? Why was there no within-group pre-/posttest comparison of students in the treatment groups?

The abstractor has observed the Computer Curriculum Corporation materials in use in a large urban school system at levels ranging from Grade 4 to Grade 10, and has talked with teachers, principals, aides, and district administrators about them. Each of the groups talked with seemed to feel that the computer-based materials help students learn mathematics. The abstractor urges the investigators to continue study of the materials and to pursue that study more carefully and in greater depth.

John G. Harvey

References

Holland, P. W., Jamison, D. T. & Ragosta, M. Computer-assisted instruction and compensatory education. Princeton, NJ: Educational Testing Service, 1978 (Project Report Number 10).

Ragosta, M., Jamison, D. T. & Holland, P. W. Computer-assisted instruction and compensatory education. Princeton, NJ: Educational Testing Service, 1978.

Suppes, P., Searle, B., Kanz, G. & Clinton, J. P. M. Teacher's handbook for mathematics strands grades 1-6. Palo Alto, CA: Computer Curriculum Corporation, 1975.

Abstractor's Comments (2)

For a variety of reasons, the research reported in this article has a great deal to say about the methods used to teach mathematics in our schools. In particular, the authors should be applauded for their demonstration of the importance of developing childrens' thinking strategies along with their ability to find answers. Although test formats, students' errors, and interviews are not new topics for mathematics education research, their combination in this study provides additional useful insights.

Before commenting on positive aspects of the study, this author would like to call attention to two issues which detract somewhat from the research. The first has to do with the study itself. The authors report that their work "drew on" and "extended" the data from a larger study. However, it was not clear, at least to this author, if any of the data from the previous study were used and reported. This author assumes that some test results were taken from the original study and that the interview results were new. However, in the absence of explicit statements to this effect, it became difficult to understand the setting of the research. For example, if revised tests were used, were they administered to the same students? This is not clear from the report, causing difficulty in interpreting and evaluating the results.

This author has commented before on the use of secondary analysis of primary data as a useful research methodology.[1] In using data banks for secondary analysis, researchers always face the problem that the data were created for purposes different from their own. At the very least, the reporting of secondary analyses should include specific indications of the distinctions between primary data and secondary analysis. The present study could have been more careful in this regard.

A second, more general comment concerns the question of the availability of important research in mathematics education. For both the present study and the Lankford study (which will be cited later in this paper), this author knew of their existence only because of circumstances not available to the vast majority of people involved in mathematics education on a day-to-day basis. This criticism is not meant to degrade the present study, but to point up the need for broader dissemination of research results in formats that are accessible and understandable to mathematics education "practitioners".

From the practitioner's point of view, this study makes important contributions. Being more involved with preservice and in-service education than in research, this author tends to place a great deal of weight on what such a study says for the classroom teacher. A general conclusion of importance to teachers -- out of many that could be drawn from the study -- involves the use of notation. Results from the part of the study dealing with format changes give some clues regarding the use of a variety of notations. These results show that changes in symbols, however slight they may be to teachers, can have a negative impact on students. As a simple example, it is easy for a teacher to <u>write</u> $\frac{N}{5} = 20$ on the chalkboard one day and then <u>type</u> N/5=20 on a worksheet or test the next day. The study shows the confusion which this can cause in students' minds. Another example of notational problems, taken from the section of the report dealing with interviews, deals with differences between reading ordinary prose vs. reading mathematical notation. Since children are taught to read from left to right, it is not surprising that the study finds confusion about the equivalence of "603 ÷ 27" (left-to-right orientation) and "$27\overline{)603}$" (right-to-left orientation). As a third example, also concerning the equivalence of numerical expressions, the study reports student difficulties across treatment groups in the task of classifying numerical expressions according to their equivalence with the target statement 3/4. These three examples, as well as many more in the study, lead to the conclusion that a teacher should not move between equivalent notations -- for whatever reason -- unless there is assurance of student familiarity, if not understanding.

The study is also to be commended for the general insights offered in error analysis and interview techniques. As mentioned earlier, results from studies of this type deserve wider dissemination. One method of dissemination is through teacher-training materials. An example of the use of error analyses in preservice teacher education can be found in the materials prepared by the Mathematics-Methods Program at Indiana University.[2] The study of computation strategies by Lankford[3] presents a very good model, as well as important results, of the use of student interviews.

The authors of the present study devote most of their "Summary and Conclusions" to a discussion of drill and practice. Since much of their data and results deal with a curriculum which includes these treatments, it is certainly appropriate that they do so. This author would like to support their conclusion that any curriculum which includes drill and practice must also include classroom teaching designed to develop understanding of fundamental concepts, as well as analysis and assessment of prerequisite knowledge.

James E. Bierden

Notes

1. Bierden, James E. Abstract of "Cognitive Results Based on Different Ages of Entry to School: A Comparative Study." In Investigations in Mathematics Education, Vol. 8, No. 4, Autumn 1975, pp. 1-3.

2. There are many units in this series which use error analysis. One example is LeBlanc, John F. et al. Addition and Subtraction. Reading, Massachusetts: Addison-Wesley Publishing Company, 1976.

3. Lankford, Francis G., Jr. Some Computational Strategies of Seventh Grade Pupils. Charlottesville, Virginia: The University of Virginia, 1972. Office of Education Project Number 2-C-013. ERIC: ED 069 496.

Larson, Carol Novillis. LOCATING PROPER FRACTIONS ON NUMBER LINES: EFFECT OF LENGTH AND EQUIVALENCE. School Science and Mathematics 80: 423-428; May-June 1980.

Abstract and comments prepared for I.M.E. by ROBERT D. BECHTEL, Purdue University Calumet.

1. Purpose

The two-fold purpose was to investigate seventh-grade students' ability to: (1) "associate a proper fraction with a point on a number line when the number line (segment) is of length one and of length two"; and (2) "associate a proper fraction whose denominator is b with a point on a number line, when the number of line segments into which each unit segment has been separated (partitioned) equals b and 2b."

2. Rationale

The investigator cites articles which report that students encounter difficulties when a number line model is used to represent fractional numbers. Problems of scaling (identifying the unit) and problems of representing fractional numbers when equivalent fractions are used were referenced. In the investigation under review four types of items, described in the next section of this abstract, were used to test the students on scale variation and equivalent fraction location.

3. Research Design and Procedures

The effect of scaling and representation of fractional numbers named by lowest terms fractions (L.T.F.) were measured by a 16-item multiple choice test. All fractions used named numbers less than 1; i.e., so-called proper fractions. The student's task was to associate a fraction $\frac{a}{b}$ with a point on a number line (segment). The four types of items were:

- L1 Length of number line was 1, $\frac{a}{b}$ was a L.T.F., and marks on the number line showed b segments in the partition of a unit.
- L2 Same as L1, except the length of the number line was 2, not 1.
- EL1 Length of number line was 1, $\frac{a}{b}$ was a L.T.F., and marks on the number line showed 2b segments in the partition of a unit.
- EL2 Same as EL1, except the length of the number line was 2, not 1.

Four items of each type made up each of the four subtests in the 16-item instrument. The numbers $\frac{1}{3}$, $\frac{1}{5}$, $\frac{2}{5}$, and $\frac{3}{8}$ were used in each subtest. According to the investigator, "the sample consisted of 382 seventh grade students, approximately half of the seventh grade students in a predominantly middle class junior high school."

4. Findings

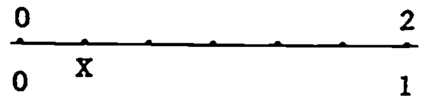
The 2 x 2 repeated measures ANOVA performed on the students' scores on the four subtests indicated that students did significantly better on number lines with length 1 than on those with length 2, and did significantly better if the number of segments in the partition of a unit matched the denominator of the fraction. Also, the means of the L1 and L2 scores exceeded both of the means of the EL1 and EL2 scores. (Means: L1, 2.67; L2, 2.32; EL1, 1.62; EL2, 1.51)

5. Interpretations

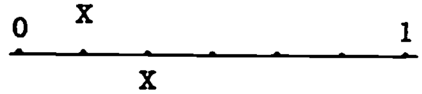
The investigator states that the results of this research "raises the question: Are we using teaching strategies, sequences, and activities that foster concept formation, or isolated rule formation?" Another quote: "the results of this study seem to indicate that some students do not have a flexible concept of equivalent fractions." Equivalent fractions, part-whole models, part-of-a-set models, the $\frac{a}{b} = \frac{a \times c}{b \times c}$ and $\frac{a}{b} = \frac{a \div d}{b \div d}$ algorithms, as well as number line models are common topics in the elementary school curriculum. Do they lead students to a well-developed concept of equivalent fractions? Evidently not, according to this investigator.

Abstractor's Comments

First, consider a few comments about the test items. Was the student subtly misled by the test items into assuming each model showed a unit? Note that only fractional numbers less than 1 were used in the instrument. If fractional numbers greater than 1 had also been used, then students might have been alerted to search for the unit. (The term proper fraction itself suggests an unwarranted and unnatural stress on fractional numbers less than 1. The term proper fraction should be banned from the mathematics curriculum.) Also, units of varying length were shown in the examples of the journal article. On page 424 we find

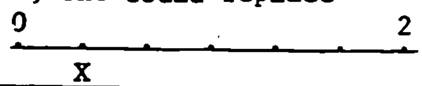


and

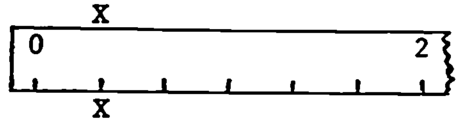


Was this also true of the test materials? Use of a common unit for all items seems preferable to the above situation. Another concern is the investigator's use of lowest terms fractions only. Again, this might mislead the student to consider "lowest terms fractions only". The inclusion of a few fractions such as $\frac{2}{6}$ and $\frac{6}{16}$ might have produced different results.

Second, the number line model is really a sophisticated ruler model. If a ruler were shown instead of a segment (or ray), would a student sense the scaling more readily? Thus, one could replace



with



The above comments can be viewed as suggestions which might be incorporated in further research.

The reviewer has the nagging feeling that altering the test items would not have significantly improved the results on student achievement. The investigator was not comfortable with this achievement. Students did not demonstrate mastery of the concept of equivalent fractions. Other studies, including NAEP, support this reaction of the investigator. In this study under review, emphasis was given to the number line model. Unit objects (an extension of the part-whole model) and unit sets can also be used to model fractional numbers greater than 1. Serious examination of all modeling of fractional numbers, starting at the beginning stages in the development of fractional number concepts, is needed. The study reviewed in this article shows that the development of fractional number concepts is non-trivial.

Mayer, Richard E. CAN ADVANCE ORGANIZERS INFLUENCE MEANINGFUL LEARNING? Review of Educational Research 49: 371-383; Summer 1979.

Abstract and comments prepared for I.M.E. by RICHARD J. SHUMWAY, The Ohio State University.

1. Purpose

To identify limitations of the review by Barnes and Clawson (1975), to present theories of the effects of advance organizers on internal cognitive processes, and to test the theories.

2. Rationale

The Barnes and Clawson review concluded "Advance organizers, as presently constructed, do not facilitate learning." Mayer deems the review limited by three difficulties: (1) inadequate statement of the to-be-tested theory, (2) inadequate analysis of learning outcomes, and (3) inadequate experimental control. Mayer identifies four theories to be tested: Reception, a one-stage model which predicts that, if a test measures content from the instructional material, presenting an advance organizer before, after, or not at all should have no difference; Addition, a two-stage model predicting that more is learned if anchoring concepts are available and more is learned if an advance organizer is presented before learning than after or not at all; Assimilation Encoding, a three-stage model predicting that giving the organizer before learning will facilitate possessing relevant knowledge in long-term memory and transferring anchoring knowledge from long-term memory to working memory; and Retrieval, which predicts that no difference will be found between advance organizers given before or after learning, since both can use the organizer as a retrieval aid during testing. Nine tests of these models are described.

3. Research Design and Procedures

Nine experiments or "tests" are described. The experiments are reported elsewhere and involve advance organizers for computer programming (Tests 1, 2, 3, 4, 5), binomial probability (Test 6), base 3 (Test 7), one-way connections (Test 8), and six-term linear ordering (Test 9). Each is discussed as a test of the four theories (Reception, Addition, Assimilation, Encoding, and

Retrieval). Each involved some factor of comparison between subjects given an advance organizer before or after learning.

4. Findings

The results provide fairly consistent support for the predictions of Assimilation Encoding regarding the effects of advance organizers on the outcomes of learning. "Advance organizers, when used in appropriate situations and when evaluated adequately, do appear to influence the outcome of learning."

5. Interpretations

The Barnes and Clawson review asked: "Do advance organizers facilitate learning?" Mayer claims to have asked: "What is learned when advance organizers are used and under what circumstances?" Mayer claims that, had he restricted himself to the first question, little would have been found. "Organizers seem to have their strongest positive effects not on measures of retention, but rather on measures of transfer." Five characteristics of advance organizers are presented and four checklist questions are proposed for judging potentially effective organizers. Mayer suggests topics in mathematics and science as most likely to be influenced by organizers.

Abstractor's Comments

I find not very remarkable the discovery that the one-stage Reception model described by Mayer is not adequate to account for learning effects. Is is not well-known that memory is enhanced by any tactic which gives meaning, nonsense or not, to symbols to be memorized? I believe Mayer has made the Reception model a strawman. Modern associative theories are not one-stage.

I also have trouble understanding why the Retrieval Theory would predict that the time at which the advance organizer was presented would have no impact on the organizer's effectiveness. Does Retrieval Theory assume a commutativity of labeling-learning vs. learning-labeling? There are no arguments given to support this interpretation, yet it is the basis for the rejection of Retrieval Theory as explaining advance-organizer effects.

The most useful discussions center about the remaining theories (Addition and Assimilation Encoding) and their relationship to the effect of transfer. I am worried that the tests of transfer may simply be tests of the content of the advance organizer. For example, in Mayer (1977b) the task was counting in base 3 using letters (w, d, r, dw, dd, dr, dww, ..., rww). The organizer was a list converting the letters to numbers (digits) w=0, d=1, r=2). Now, if the transfer task is to count further than the memory task using letters, or to perform simple addition with the letters, are we actually surprised that prior practice making the conversions to numbers would facilitate this transfer? Is it really still transfer? Isn't it simply applying prior knowledge about numbers, facilitated by the practice of the learning task (practice only available to those giving the converting list first)?

It seems to me there are two errors we can make. One would be to dismiss the work because laboratory experiments have nothing to do with mathematics. The other would be to note an apparent difficulty which common teaching experience regarding base 3 reveals and dismiss the work as a trivial result. No experiments are without alternative explanations and Mayer's efforts to test learning models facilitates greatly the ability to suggest alternatives. This is a laudable effort to examine conceptual frameworks for advance organizers and should be rewarded with careful study and further work.

As a footnote to Mayer's call for work in mathematics and science, there is an excellent work in advance-organizer research using meta-analysis which should be "must" reading for those interested in advance organizers and/or meta-analysis techniques (Kozlow and White, 1979). The paper is excellent follow-up to Mayer's work.

References

Kozlow, M. J. and White, A. L. A meta-analysis of selected advance organizer research reports from 1960-1977. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Atlanta, Georgia, March 21-23, 1979.

McLeod, Douglas B. and Briggs, John T. INTERACTIONS OF FIELD INDEPENDENCE AND GENERAL REASONING WITH INDUCTIVE INSTRUCTION IN MATHEMATICS. Journal for Research in Mathematics Education 11: 94-103; March 1980.

Abstract and comments prepared for I.M.E. by JERRY P. BECKER, Southern Illinois University.

1. Purpose

The researchers investigated two questions suggested by previous ATI research: (1) Can the interaction of field independence with the level of instructional guidance in mathematics be extended to the sequence of instruction? (2) Will an interaction with general reasoning occur with treatments that differ only in the use of an inductive sequence of instruction?

2. Rationale

Following their own earlier research and that of others, the researchers discussed how differences between field-dependent and field-dependent learners appear to be related to some aspects of discovery learning. In particular, it is conjectured that since other research suggests field independence to interact with amount of guidance, it therefore may be related to inductive and deductive teaching (Witkin, Moore, Goodenough, and Cox, 1977; McLeod, Carpenter, McCormack, and Skvarcius, 1978). Similarly, interpretations were made of earlier research by Eastman and Carry (1975) which seem to suggest interaction due to a relationship between general reasoning and inductive and deductive teaching approaches. Thus, the researchers set out here to explore the existence of ATI's between aptitude variables (field independence and general reasoning) and treatment variables (inductive and deductive instructional approaches). In setting the context, the researchers also discussed the authoritative writings of Cronbach and Snow (1977) and Glaser (1972).

3. Research Design and Procedures

Subjects were upper-division university students in a preservice mathematics course for elementary teachers: 33 subjects were randomly assigned to each treatment group (inductive and deductive). Subject matter was concerned with reflexive, symmetric, and transitive properties of equivalence relations. The same content, presented in a programmed format, appeared in each treatment, and physical manipulative learning materials were used to introduce concepts.

The Hidden Figures Test (HFT), somewhat modified, was used to measure field independence and the Necessary Arithmetic Operations Test (NAO) was used to measure general reasoning. Two post-treatment measures were devised: immediate achievement and transfer. The first assessed understanding of concepts presented in the treatments; the latter included no items that had been taught in the treatments.

Data were gathered over a span of five 75-minute class periods as follows: period 1 - HFT was administered; period 2 (five days later) - subjects worked through the treatment to which they were previously assigned (as a function of HFT scores) and also completed the achievement test; period 3 (two days later) - transfer test was administered; period 4 (four weeks later) - achievement and transfer measures were readministered as retention tests; period 5 (several weeks later) - NAO test was administered. Subjects were given 60 minutes to complete their assigned treatment. Between days during which data were gathered, subjects engaged in normal course activity.

Data were analyzed using multiple regression techniques, separately using the four dependent variables: immediate achievement test (IA), transfer test (TT), achievement-retention test (AR), and transfer-retention test (TR). Each dependent variable was checked for an interaction with each of the two aptitudes: if an interaction was found, the regions of significance were determined; if no interaction was uncovered, then data were analyzed further, exploring whether any treatment differences existed.

4. Findings

Significant, disordinal interactions were found between HFT and treatment on TT, and between NAO and treatment on both IA and TR. Further analysis showed that interactions with NAO can be attributed to NAO alone. On the TT, the interaction with HFT was significant, and the interaction with NAO was nearly significant. Further analysis showed that the interaction with the sum of the two predictors was not stronger than with either predictor separately, while the interaction with their difference was quite strong; the reason given was that the interactions with HFT and NAO were in opposite directions.

The Johnson-Neyman technique was applied to each interaction using one predictor variable: regions of significance (.05) were determined for both interactions involving NAO. In each case subjects in the deductive [illegible] ment scored significantly higher when their scores were 19 or more [illegible] the subjects had scores in this range). For the interaction involving HFT, no subject fell in the region of significance (at the .05 level). Following the suggestions of Cronbach and Snow (1977), the researchers did an analysis using confidence intervals which shed further light on "regions of significance" as information that could be used in making placement decisions.

5. Interpretations

Among the researchers' interpretations of the results are the following (pp. 101-102): (1) inductive/deductive instructional approaches do not seem to interact strongly with field independence (HFT), but do with general reasoning (NAO); (2) absence of interaction with HFT may be due to the highly structured nature of the learning treatments; (3) results in this study do not seem to support Cronbach and Snow's (1977) hypothesis that most ATI's come from general ability (see p. 102 for more on this); (4) following Carroll (1976), the researcher pointed out that "NAO uses cognitive processes in an 'executive' in order to retrieve algorithms and perform serial operations" (p. 102). Thus, they observe, perhaps subjects who are adept at carrying out serial operations are at a disadvantage by the nonserial characteristic of an inductive approach to instruction.

Abstractor's Comments

This is an interesting ATI study carried out in good fashion, and the researchers nicely relate their study and findings to the work of other researchers. There are a few reactions I have:

(1) While the researchers give a description of the content in the treatments, no examples are given of the treatment materials -- a few 'frames' of the programmed materials would help to give readers a better 'feel' for the study; similarly for the posttests.

(2) No explanation is given of why NAO was administered after subjects completed the treatments. In such a situation, isn't there risk that performance on NAO will be influenced by subjects first

working through the programs? If so, this would seem to run contrary to use of NAO as a predictor variable in the research and in placement decisions of subjects to treatment.

(3) It might be useful for the reader to have an indication of which correlations between HFT, NAO, IA, TT, AI, and TR were significant, if any.

(4) The researchers found no significant HFT x treatment interaction for three of the four dependent variables. One wonders whether this might be attributed to the short duration of the treatments (60 minutes). I wonder whether ATI researchers can ever hope to make significant progress unless treatments of longer duration are used; further, longer treatments might help to make our research more generalizable to classroom situations than now seems possible.

Menis, Yoseph; Snyder, Mitchel; and Ben-Kovah, Ezra. IMPROVING ACHIEVEMENT IN ALGEBRA BY MEANS OF THE COMPUTER. Educational Technology 20: 19-22; August 1980.

Abstract and comments prepared for I.M.E. by J. FRED WEAVER, The University of Wisconsin-Madison.

1. Purpose

The objectives of the authors' project (supported by the Ford Foundation) were: "(1) to improve the attitudes toward mathematics and the natural sciences among high school pupils who had received low grades in these subjects; and (2) to improve their grades in these subjects."

2. Rationale

It is contended that many high school students do poorly in mathematics and report having a "mental block" against mathematics "because mathematics is the most abstract of all the subjects taught in high school." Hence, "It is necessary to adapt the method of teaching to the psychological maturity of the pupil. It is necessary to teach an abstract subject only on the level of abstract thinking that the pupil has reached. It has been found that only 14 percent of pupils in grade ten in Israel . . . and in England . . . have reached the stage of later formal operations of Piaget and are capable of abstract thinking." The authors believed "that working with a computer will make mathematics more interesting as well as help the pupil to understand the abstract concepts in mathematics better than he or she would by doing exercises by hand."

3. Research Design and Procedures

"The experiment took place during a period of three years: 1975-1977. The participants in the experiment were tenth grade algebra pupils who had low grades in mathematics at the end of the ninth grade. They spent about half an hour a week at the terminal doing exercises in algebra under the supervision of the algebra teacher. These pupils were compared with all the rest of the tenth grade pupils."

In 1975 there were 77 "experimental" and 52 "other" pupils.

In 1976 there were 21 "experimental" and 131 "other" pupils.

In 1977 there were 48 "experimental" and 73 "other" pupils.

The following quotations from the journal article indicate the general nature and flavor of the experimental treatment:

"The mathematics teachers in the participating classes submitted to us the curriculum for tenth grade algebra, listing in detail the topics to be covered, week by week. Hundreds of drill exercises on each topic were written by the teacher and the field coordinator.

"During the first year of the research . . . eight booklets were written for the pupils. Each booklet contained ten lessons and hundreds of exercises in algebra. These were two kinds of exercises:

"exercises in using the computer as a desk calculator. These enabled the pupil to use the computer to do arithmetic calculations in later lessons; and

"drill exercises in the material learned in the classroom. These enabled the pupil to solve many more homework problems than he or she could have by hand."

The mathematics curriculum was changed at the end of the first year and another booklet was written in which "each lesson begins with a solved exercise followed by many drill exercises."

How were the booklets used? "The teacher assigned the pupil several exercises in each lesson. The number of exercises and the degree of difficulty were determined by the teacher based on his or her appraisal of the pupil's ability. The pupil sat at the terminal and typed in the lesson number. The computer typed back an enumerated list of possible answers and then typed the exercises, one by one. In reply to each exercise, the pupil was to type the number of the answer that seemed to him or her to be correct. If it was correct, the computer typed 'right.' Otherwise, the computer typed 'try again' and the pupil had two more opportunities before the computer told him or her the correct answer. At the end of the session, the pupil brought his or her paper to the teacher who then decided whether or not the pupil needed further drill in that lesson."

In the booklet used at the beginning of the second year "there was an added feature. At the beginning of each lesson was an exercise worked out step by step, prompted by the computer. The lesson was designed to ensure that the pupil understood the method for solving exercises of that type in the lesson."

(No further information of any consequence concerning "treatments" is included in the report.)

The authors briefly discuss "the programming language" (APL), "training and teachers," and "technical considerations" (pertaining to the use of IBM 2740 interactive terminals with a 370/168 computer). In regard to the "measuring instruments" used, they state:

"To measure the extent to which the method affected achievement in mathematics, the marks in mathematics at the end of the ninth grade and at the end of the tenth grade were recorded.

"To measure the change in attitudes, a questionnaire was designed. It contained 40 statements, and the pupil had to indicate the extent of his or her agreement or disagreement with each on a scale of 1-5. (In 1975, we used a scale of 1-7 but then saw that it was too fine for the pupils. In order to combine the results of that year with those of the following years, we telescoped the 1-7 scale as follows: 1, 2→1, 3→2, 4→3, 5→4, 6, 7→5.)"

4. Findings

"The changes within each group were measured using the paired-comparisons *t*-test on the 'before' and 'after' mathematics grades and the answers to the questions on the questionnaire. The groups were compared with each other using the *t*-test for two independent samples on the differences."

The following table was presented, apparently covering all three years of the project, and represents the full extent of such data presented in the report:

Changes in Achievement

	Experimental Group N=146	Rest of the Pupils N=256
Average Grade at End of Ninth Grade	5.3	7.4
Average Grade at End of Tenth Grade	5.8	7.3
Average Change	+0.5	-0.1
P-Value for Significance of Change	.001	.31

The authors contend that from the preceding table "it can be seen that the better mathematics students did not improve their grades on the average during the tenth grade, whereas the weaker students, who participated in the project, did improve on the average. Not all of them received a passing grade (6.0), yet many more passed than would have otherwise. The difference between the average change in the experimental group and the average change among the other pupils is significant at the .02 level."

It also was reported that:

"Both groups liked mathematics less (on the average) at the end of tenth grade than at the beginning of tenth grade. But, the drop was much less significant in the experimental group.

"This result is in concordance with the hypothesis that pupils who use the computer in conjunction with learning mathematics will have a more positive (or less negative) attitude toward mathematics."

"The experimental group liked physics significantly less at the end of the year than at the beginning of the year. On the other hand, there was no change among the rest of the pupils."

"This result might indicate that the influence of using the computer in learning mathematics is restricted to the attitude toward mathematics and does not extend to other related subjects."

The following observation pertained to students' feeling about whether "computer studies" would "contribute" to their "ability" in "mathematics and the natural sciences":

"There was no significant change among the pupils in the experimental group, while there was a significant drop in the average of the others.

"This result is also in concordance with the hypothesis of the research, as well as with the results of the mathematics grades, where the experimental group improved and the others did not."

5. Interpretations

"It is our opinion that properly used the computer can be harnessed as an aid in raising the standards of weaker pupils in many subjects."

Abstractor's Comments

The instructional psychology implicit in the report took me back 45 years to the beginning of my own teaching which was dominated by an S-R bond Thorndikian psychology of learning.

I quoted rather than paraphrased much material from the research report simply to avoid the possibility of being misinterpreted in what was said.

The paucity of information included in this report of a three-year investigation makes it utterly impossible for me to react to or comment upon the investigation with any assurance regarding the validity of such reactions or comments. Therefore, I stand mute,--even in the face of statements in which "more positive" in essence means "less negative,"--and remain in ignorance regarding the computer's influence upon achievement in algebra.

Mezynski, Karen and Stanley, Julian C. ADVANCED PLACEMENT ORIENTED CALCULUS FOR HIGH SCHOOL STUDENTS. Journal for Research in Mathematics Education 11: 347-355; November 1980.

Abstract and comments prepared for I.M.E. by KENNETH E. VOS, College of St. Catherine.

1. Purpose

A description is given of two supplementary calculus classes sponsored by the Study of Mathematically Precocious Youth (SMPY) at Johns Hopkins University during 1974-75 and 1975-76. This research article compared two different fast-paced calculus classes and reported their success in the Advanced Placement (AP) examination in level BC calculus.

2. Rationale

Students within the two fast-paced calculus classes were concurrently enrolled in a high school calculus course. The involvement in SMPY was an additional means to maximize their performance on the AP examination in level BC calculus.

The rationale for attendance in the SMPY project was threefold:

1) to improve scores on the AP examination,
2) to provide exposure to a greater breadth and depth of calculus topics
3) to provide an intellectual challenge.

Various references were listed which describe some of the other fast-paced classes in the SMPY project.

3. Research Design and Procedures

The two classes involved in this study were identified by academic year -- Class I was held during the 1974-75 academic year and Class II was held during the 1975-76 academic year. Both classes met for at least 2 hours each Saturday for 30 weeks. The two classes were taught by the same college mathematics instructor.

During the two different academic years, Classes I and II were identical in course structure and goals: however, the two classes differed in age, high school grade, means of selection, and previous mathematics training.

Class I:

-beginning enrollment: 15, all male

-ending enrollment: 13

-attended previous fast-paced mathematics instruction: 11

-mean age: 14.9 years

-most were 10th graders

-no specific procedure stated for selection

-majority enrolled in previous SMPY courses

Class II:

-beginning enrollment: 23; 18 males, 5 females

-ending enrollment: 12; 10 males, 2 females

-attended previous fast-paced mathematics instruction: 2

-mean age: 16.7 years (calculated from data)

-most were 12th graders

-selection requirements based on SAT or PSAT scores for mathematical and verbal sections

The following tests were administered to the calculus classes:

Class I: Forms A and B of the Educational Testing Service's Cooperative Mathematics Tests in Calculus (CMTC)
AP examination in level BC calculus

Class II: Form B of CMTC
AP examination in level BC calculus

4. Findings

For Class I:

-on Form A of the CMTC, all 13 students scored above the 99th percentile of the national college norms

-on Form B of the CMTC, 11 students scored above the 99th percentile, 1 scored at the 98th percentile, and 1 scored at the 94th percentile of the national college norms

-on the AP examination level BC, 9 students received the highest grade of 5, 3 students received a grade of 4 and 1 student received a grade of 3

For Class II:

-on Form B of the CMTC, 9 students scored above the 99th percentile, 2 students scored at the 98th percentile, and 1 student scored at the 92nd percentile of the national college norms

-on the AP examination level BC, 4 students received the highest grade of 5, 4 students received a grade of 4, 3 students received a grade of 3, and 1 student received a grade of 2

5. Interpretations

A comparison of the scores of these two classes was made with the scores of other gifted mathematics students who did not take these specific classes and the scores of the students who enrolled in the classes but later dropped out. All the students involved in the comparison were enrolled in high school calculus courses.

The scores from the AP examination level BC calculus of a set of students enrolled in a high school calculus class were compared to the scores of Classes I and II. Class I definitely was superior to Class II and the high school class. "For Class I, the mean AP grade was 4.62, with standard deviation 0.65. Class II's mean grade was 3.92, and the standard deviation was 1.00. The mean grade for the high school class was 3.39, with standard deviation 0.96. A one-way analysis of variance determined a significant difference among the means: $F(2,35) = 15.60$ ($p < .01$)." The supplementary instruction did improve the scores especially for Class I. In general, the supplementary instruction possibly raised the AP scores by one or more grades; that is, moving a 3 grade to a 4 grade. Students in both classes received higher AP scores than high school students without the supplementary instruction.

Of the two students who dropped Class I, one took the BC level test and scored a 3 and the other student took the AB level test and scored a 3. Of the 11 students who dropped Class II, six took the BC level test and scored a 4, one took the AB level test and scored a 4, three did not take either test, and one student could not be contacted.

A list of six general guidelines for establishing supplemental calculus classes was included.

Abstractor's Comments

The authors of this article should be commended for offering the mathematics education profession another piece to the jigsaw puzzle--teaching the talented mathematics student. Their list of six guidelines for establishing supplemental calculus classes should be valuable to school districts or projects contemplating such a program. The guidelines included student selection ideas, the role of a concurrent high school calculus course, class size, instructor characteristics, homework and attendance, and textbook selection.

Unfortunately, I believe the article has been published in an inappropriate journal--a research journal. The majority of the article was informative for applying the guidelines, but the purpose of the study did not directly relate to the guidelines. It should be noted that the six guidelines were only a small portion of the total article.

This abstractor's bias would rate this research study a grade of 2 (on a scale of 1-low to 5-high where a 2 means "possibly qualified"). The study probably was not planned as a "research" study but rather as part of an evaluation plan of a project. This is evident in the lack of carefully controlled variables such as the reasons for students dropping the classes, response or lack of response by potential Class II students, student selection process, comparison group, and testing procedures.

I am reluctant to delineate a laundry list of concerns related to the research design, control of variables, testing procedures and interpretation of the results. The reluctance is not because the list would be short but rather it would be counterproductive. As stated before, the article was published in an inappropriate journal. With slight revisions of the article it should have been published in a journal which has a more general audience of classroom teachers.

Olson, Alton T. and Gillingham, D. Elaine. SYSTEMATIC DESENSITIZATION OF MATHEMATICS ANXIETY AMONG PRESERVICE ELEMENTARY TEACHERS. Alberta Journal of Educational Research 26: 120-127; June 1980.

Abstract and comments prepared for I.M.E. by MARY C. SCHATZ and ELIZABETH FENNEMA, University of Wisconsin-Madison.

1. Purpose

The primary purpose of this study was to investigate the hypothesis that giving systematic desensitization therapy to preservice elementary school teachers, who had high mathematics anxiety, would reduce their anxiety. Secondary purposes included investigations into the relationship between attitudes and anxiety toward mathematics and the effects of systematic desensitization on this relationship; the relationship between introversion-extraversion and anxiety; and the status of mathematics anxiety as a stable trait or as a transitory state.

2. Rationale

Systematic desensitization has been shown to be an effective technique for reducing a variety of fears. In systematic desensitization, deep muscle relaxation is used to help the subject break the association of anxiety with a particular stimulus and build an association of relaxation with the stimulus. In this study, this technique was applied to the mathematics anxiety of preservice elementary teachers.

3. Research Design and Procedures

At the beginning of the school term, 141 students in an elementary education mathematics methods course were given the Mathematics Anxiety Rating Scale (MARS). Fifty-one of these students were identified as being in the high-anxious group. Of these, 24 volunteered to accept the systematic desensitization therapy treatment and were randomly assigned to two treatment groups (A and B). The high-anxious non-volunteers made up group C, and group D consisted of the mid/low-anxious students.

In the first stage of the experiment, all groups were pretested using four instruments: (1) the MARS, (2) the Aiken Attitude Scales, (3) the State-Trait Anxiety Inventory (STAI), and (4) the Eysenck Personality

Inventory (EPI). In the second stage, group A received the therapy treatment. The treatment lasted three weeks, after which groups A and B were given the MARS and the Aiken Attitude Scales. In the third stage of the experiment, group B was given the three-week therapy treatment, after which groups A and B were again given the MARS and the Aiken Attitude Scale. In the fourth and final stage, all four groups were given these two instruments.

4. Findings

(a) The data from stage two of the experiment (in which group A received treatment and group B was a control group) were analyzed using a two-way ANOVA with repeated measures on the MARS as one of the factors and the groups as the other factor. This yielded a statistically significant difference in the repeated measures and also showed an interaction between the repeated measures and the group factor.

(b) The mean scores on the MARS from the first and last stage of the experiment for all four groups were also analyzed using a two-way ANOVA. This analysis revealed a statistically significant reduction in mean scores for all groups except group D.

(c) The scores on the MARS were also analyzed for group A and group B separately, over all four experimental stages. A multivariate analysis was used, and it was found that group A's post-therapy MARS scores were significantly lower than the pre-therapy MARS scores. No such statistically significant differences were found for group B.

(d) From the testing done in the first stage of the experiment on all four groups, the investigators reported means, standard deviations, and correlations between the MARS, EPI, and STAI instruments. The correlations of the MARS with the neuroticism and extraversion subscales of the EPI and the state and trait subscales of the STAI were .425, -.087, .412, and .540. All but the second were significantly different from zero.

(e) The Aiken Attitude Scales were analyzed the same way as the MARS scores were analyzed; no significant differences were found.

5. Interpretations

The researchers concluded that "systematic desensitization as a therapeutic procedure to alleviate mathematics anxiety was successfully demonstrated"

(p. 125). They noted also that "attitude toward mathematics is not an isolable phenomenon. It seems to be related to a more globally defined notion of anxiety" (p. 126). They point out that one limitation of their study is the inability to separate the effect of the therapy from the effect of the therapist.

Abstractor's Comments

This study addresses the problem of mathematics anxiety, which is a growing area of concern in mathematics education. Mathematics anxiety often leads to mathematics avoidance, which in turn leads to a curtailment of career options. Mathematics anxiety has received much attention in the lay press. It is time now for mathematics education researchers to apply their knowledge and efforts to finding some solutions to the problem of mathematics anxiety. Although the investigators have chosen an important area, some questions need to be raised concerning several aspects of their study.

1. First, there are some problems with the description of the sample. It sounds at first (p. 121) as if all groups were taken from the elementary mathematics methods class. However, later in the article (p. 125) group C is singled out as being enrolled in an elementary mathematics methods class, as if the other groups were not. Some clarification of this is needed.

Another problem concerns the size of the sample. The authors note that the size of each group decreases over time due to class attrition. While this is clear, it is not clear why there is a difference in sample size from Table 1 to Table 3. Table 1 shows that at the first test occasion, there were 141 subjects, but Table 3 shows that at the first test occasion, there were only 125 subjects. No explanation is given for the discrepancy. Also, although the overall sample size (125) is adequate, the number of subjects in the treatment group is actually quite small. Group A started with 11 and ended with 8 subjects, and group B started with 13 and ended with only 7 subjects. The analyses and conclusions based on this small a sample are inappropriate.

A third problem related to the sample is that the "high-anxious group" is not clearly defined. It is only described as the students who scored "highest" on the MARS. This loose definition implies that the high-anxious "cutoff" of one sample would not necessarily be the high-anxious "cutoff" of another sample. A definition that is sample-dependent weakens the generalizability of the study.

A final problem with the sample is that those who received the therapy treatment were volunteers. This again hurts the generalizability of the study.

2. The procedure that was used in the study also calls for some comment. Groups A and B both consisted of high-anxious students and both groups received the desensitization therapy. The authors point out that group B was treated three weeks after group A. There is again no explanation given as to why the investigators felt it was important to have this time lag.

Only a general description of systematic desensitization therapy was given. A more detailed description of the exact nature of the treatment in this experiment was needed. Also, no mention was made of who the therapist was. Since the investigators concluded that the effect of the therapist may have been a confounding factor, it would have been helpful to have had more information about the therapist.

3. More information should have been given about the instruments used. The scoring on the MARS, EPI, and STAI is not explained at all, so reporting means on these instruments is not helpful. Also, no explanation is given as to why the investigators felt the Aiken Attitude Scales were appropriate. It is entirely plausible that mathematics anxiety is not at all related to the "value of mathematics," so use of that subscale especially needs to be justified. Furthermore, the validity of the Aiken Attitude Scales for this study is not reported.

4. The data and analyses were reported incompletely. For example, rather than report means in both tabular form and paragraph form, the authors could have reported them just once, and then included the ANOVA tables. Also, data from the Aiken Attitude Scales was not included at all.

5. The first and major conclusion that the investigators made is that "systematic desensitization as a therapeutic procedure to alleviate mathematics anxiety was successfully demonstrated." However, this seems to be true <u>only</u> of group A and not of group B. No statistically significant difference was found in the pre- and post-treatment scores of group B. Therefore, having one group where a difference was detected and another group where one was not, does not seem to be grounds to claim that the treatment was successful.

6. There are several very important questions which the investigators

did not address at all. First, one important consideration is: how long-lasting are the effects of this treatment? Does one need to undergo therapy every six months? Also, how much is the anxiety reduced? Is it reduced substantially so that it is no longer an impediment to one's achievement? Or is it only reduced a statistically significant amount?

Related to this last point is the fact that this study did not look at mathematics achievement at all. It would have been interesting to have had pre- and post-treatment measures of achievement.

Lastly, we must consider how practical it would be to use this therapy technique on a large scale. Can it be done in a large group, or is it an individual therapy? Who can serve as a therapist? Can classroom teachers be trained to recognize and treat the anxiety of their students?

Pereira-Mendoza, Lionel. THE EFFECT OF TEACHING HEURISTICS ON THE ABILITY OF GRADE TEN STUDENTS TO SOLVE NOVEL MATHEMATICAL PROBLEMS. Journal of Educational Research 73: 139-144; January/February 1980.

Abstract prepared for I.M.E. by GERALD A. GOLDIN,
Northern Illinois University
Comments prepared for I.M.E. by GERALD A. GOLDIN and by FRANK K. LESTER, JR., Indiana University.

1. Purpose

This study was designed to investigate whether students can be taught to apply the heuristic processes of "examination of cases" and "analogy" to non-routine mathematical problems. The effects of teaching heuristics only, heuristics combined with mathematical content, and content only were compared. The mathematical context of instruction was also varied, and the effects compared of teaching in algebraic, geometric, and neutral contexts.

2. Rationale

Inspired by George Polya, a growing number of researchers have employed instructional procedures based on mathematical problem-solving heuristics. Such procedures are consonant with often-expressed objectives for education. The preponderance of research evidence suggests that the teaching of heuristic processes does improve the problem-solving performance of students. This study seeks to contribute by examining for a relatively larger number of subjects the use of previously taught heuristic processes in novel test situations.

3. Research Design and Procedures

The study was based on 3x3 factorial design. An "instructional objective" factor was described by the codes: H (heuristics only), HC (heuristics with content), and C (content only). A "vehicle of instruction" factor was described by the codes: A (algebraic, G (geometric), and N (neutral). Nine self-instructional booklets of parallel form were developed, corresponding to the nine possible combinations. Each booklet discussed three topics, with three days devoted to each topic and a final day for review. Corresponding topics in the booklets were of identical mathematical structure, but embedded in A, G, or N contexts. For example, the A topic

"Mappings" corresponded to the G topic "Flips and Turns" and the N topic "Tiling." The H and HC booklets contained material showing how "systematic examination of cases" or "analogy" could be used in exploring the possibilities, while the C booklet merely listed possibilities. In addition, H and HC booklets contained pages describing the use of these heuristic processes which were omitted from the C booklet. The H booklet concentrated solely on teaching heuristics, while the HC booklet emphasized both heuristics and content.

An algebraic and a geometric posttest were developed. These consisted of two questions each, posed in the format, "What can you find out about ...?" In the algebraic posttest, two novel operations were posed in *modulo* 7: "up-one multiplication," a@b = ax(b+1), and "double addition," a#b = 2x(a+b). In the geometric posttest, students were provided with rules for moving on a grid and computing distances. They were then asked, "What can you find out about shortest routes and combining shortest routes?" Scoring was based on use of the two heuristic processes: 0 = no evidence of either process, 1 = examination of cases but no attempt to look for a pattern, 2 = examination of cases and looking for a pattern, 3 = analogy only, 4 = both heuristic processes used distinctly, and 5 = both heuristic processes used together.

The subjects were 294 tenth-grade boys from an all-male Eastern Canadian high school, randomly assigned to the nine experimental groups. Each group was given a different self-instructional booklet, with one day's work administered and corrected at a time. Data were included in the study for students who completed nine of the ten days of instruction. The posttests were scored individually by three judges, and disagreements were resolved in meetings. All three judges agreed on 98% of the algebraic tests, and 96% of the geometric tests; the remainder were dropped from the study. Data for subjects who took only one posttest were also discarded.

Additional subjects were randomly eliminated to achieve an equal number (21) in each cell, for a total of 189 subjects. Data for these subjects were reported descriptively in separate tables for the algebraic and geometric posttests. For purposes of statistical analysis, subjects were scored 0 if no heuristic process was used, and 1 if any heuristic process was used (previously 1, 2, 3, 4, or 5). Means and standard deviations for each cell were tabulated. Parallel analyses of variance for the two posttests were carried out to test several null hypotheses using the *a posteriori* Scheffé procedure, and the overall F-ratios tabulated.

4. Findings

On the algebraic posttest, a substantial number of students used "examination of cases" (18 were scored 1 or 2), a substantial number used "analogy" (14 were scored 3), and a substantial number used both processes (40 were scored 4 or 5). On the geometric posttest many more students used "examination of cases" (89 were scored 1 or 2), virtually no one used "analogy" (1 was scored 3), and very few used both processes (0 were scored 4, while 9 were scored 5).

When means were computed using scores of 0 or 1, it turned out that on both posttests, for each "vehicle of instruction," mean (H) > mean (HC) > (C), with the one exception that for the geometric posttest, mean (H-G) = mean (HC-G) > mean (C-G).

At the .05 level of significance, there were no significant effects due to the "vehicle of instruction" variable (A, G, or N). The scores of the H subjects were significantly higher than those of the C subjects on both posttests. The scores of the HC subjects were significantly higher than those of the C subjects on the geometric posttest, but not on the algebraic posttest. The scores of the H subjects were significantly higher than those of the HC subjects on the algebraic posttest, but not on the geometric posttest. No significant interaction effects were found.

5. Interpretations

The author concludes that at least one heuristic process, "examination of cases," can be taught so that it is applied in unfamiliar algebraic and geometric test situations. Teaching heuristics alone appears to be more effective than in combination with content. The students' ability to apply heuristic processes is independent of the mathematical context (A, G, or N) used to teach heuristics.

A number of limitations of the study are noted: the use of an all-male sample, the use of self-instructional booklets, the limited selection of mathematical topics, and the fact that only two heuristic processes were taught. It is also noted that the nature of the posttests is crucial to the ability of the students to apply the heuristic processes; the non-use of the "analogy" process on the geometric posttest may have been due to the test questions rather than to inadequacies of learning during the treatment phase.

Abstractor's Comments (1)

This study is ambitious in its effort to measure the effects of teaching heuristics to large numbers of students. Other studies have employed fewer subjects in order to be able to examine individual problem-solving protocols (Schoenfeld, 1979a).

The use of self-instructional booklets minimizes effects which may be attributable to particular teachers. No sample activities are included in this paper, so it is not possible to judge the degree to which parallelism was achieved in the booklets. The descriptions of "heuristics only," "heuristics with content," and "content only" are vague. Apparently the H booklets make some reference to mathematical content in illustrating the use of heuristic processes, but to a lesser degree than the HC booklets. The reader is given only subject titles to illustrate the classification of topics as "algebraic," "geometric," or "neutral." Personally I would have called the topic "Tiling" a G topic rather than an N topic, judging from its title. There was no discussion of validation procedures for the booklets.

The pencil-and-paper posttests do not contain "problems" in the usual sense, since there are no well-defined goals specified. They are instead open-ended discovery activities. The question of associating heuristic processes with the intrinsic structure of problem-solving activities has been raised by several authors (Harik, 1979; McClintock, 1979; Schoenfeld, 1979b). Apparently no pilot test was conducted in this study to determine the appropriateness of the posttest activities for measuring use of the heuristic processes in question. Thus it is later noted that the geometric posttest may have been inappropriate for eliciting the use of "analogy." This posttest was not fully described in the paper.

There is considerable evidence that the process of problem-solving is sensitive to small changes in the way questions are worded (Caldwell & Goldin, 1979; Goldin & Caldwell, 1979). It is possible that the students who received H instruction showed increased use of heuristics over HC and C students because they understood the question, "What can you find out about ...?" in the more precise form, "Use trial-and-error to find out about ...". Perhaps if the latter directions had been given, all students would have shown substantial use of heuristics, independent of the ten days of instruction. This point is made because the posttests were scored for evidence of <u>use</u> of heuristic processes, but not necessarily for <u>successful</u> use. The H students certainly showed increased <u>actual use</u> of the heuristic processes in some situations, but not necessarily an increased <u>ability</u> to use them. This more limited interpretation of the experimental findings makes it more plausible that the H students scored higher than the HC students, and qualifies the author's conclusion that it is more effective to teach heuristics alone than in combination with specific content.

The scoring of the posttests may have understated the use of heuristics, since it was based on students' written work exclusively. No criteria are given for the scoring--while a committee of three reached agreement, no information is provided concerning their basis for agreement. Without this information, it would not be possible to replicate the study.

In interpreting the findings on the algebraic posttest, it would have been helpful to know whether the students had prior instruction in modular arithmetic in their school programs, or whether the "*modulo* 7" part of the operation was also new to them.

In reporting the data, there was no reason to eliminate subjects in order to equalize cell numbers in the <u>descriptive</u> tables. These tables, showing scores of 0, 1, 2, 3, 4, or 5 on each of the two posttests, are of greater interest than the later tests of statistical significance, and should have included all the raw data.

To sum up, this study is a worthwhile undertaking which leave many gaps and unanswered questions in the published paper.

Gerald A. Goldin

References

Caldwell, J. H. and Goldin, G. A. Variables affecting word problem difficulty in elementary school mathematics. <u>Journal for Research in Mathematics Education</u>, 1979, <u>10</u>, 323-336.

Goldin, G. A. and Caldwell, J. H. Syntax, content, and context variables examined in a research study. In <u>Task Variables in Mathematical Problem Solving</u> (G. A. Goldin and C. E. McClintock, Eds.). Columbus, Ohio: ERIC Clearinghouse for Science, Mathematics and Environmental Education, 1979.

Harik, F. Heuristic behaviors associated with problem tasks. In Task Variables in Mathematical Problem Solving, op. cit., 1979.

McClintock, C. E. Heuristic processes as task variables. In Task Variables in Mathematical Problem Solving, op. cit., 1979.

Schoenfeld, A. H. Explicit heuristic training as a variable in problem-solving performance. Journal for Research in Mathematics Education, 1979, 10, 173-187. (a)

Schoenfeld, A. H. Heuristic behavior variables in instruction. In Task Variables in Mathematical Problem Solving, op. cit., 1979. (b)

Abstractor's Comments (2)

How to incorporate problem-solving instruction into the school mathematics curriculum is an extremely important issue in contemporary problem-solving research. For this reason alone Pereira-Mendoza's research merits serious attention. In particular, the purpose of his study was to determine if problem-solving heuristics should be taught separately from or in conjunction with standard mathematics content. He has identified an especially timely problem to study in view of the current concern that problem-solving play a more prominent role in mathematics instruction at every level. Unfortunately, the study has serious design limitations and the descriptions of the instructional treatments are very inadequate. In addition, I think the implications suggested by the author are largely unwarranted. For these reasons alone it is impossible to draw any confident conclusions except to suggest that students become better able to use particular heuristics if the students have been trained in the use of those heuristics--clearly, a rather obvious observation.

Regarding the problems with the research design, three points concern me. First, three instructional treatment groups were considered: H - treatment designed to teach heuristics only; HC - treatment designed to combine instruction in heuristics with the teaching of mathematics content; and C - treatment designed to teach mathematics content only (no instruction in the use of heuristics). These three groups constituted the instructional treatment factor of a two-factor research design. The second factor, instructional vehicle, included three approaches to presenting content (viz., algebraic (A), geometric (G), and neutral (N)). Thus, when these two-factors were crossed nine experimental groups resulted: H-A, H-G, H-N, HC-A, HC-G, HC-N, C-A, C-G, and C-N. It is difficult for me to see how groups H-A, H-G, and H-N can be legitimately considered as concentrating "... solely on teaching heuristics" (p. 140). At the same time, the three HC groups supposedly were taught both heuristics and content but exactly what content was taught in these groups which was not taught in the H groups is not at all clear. The point is, then, that I am concerned that the H groups and HC groups were not clearly different. For example, the author states "... in providing solutions to the problems under Topic 1 and Topic 2, the H and HC booklets contained explanations of how the different permutations, seating plans, or arrangements could be obtained by using a systematic examination of cases" (p. 140). Surely, if this statement accurately reflects what actually took place, both groups were taught "content." A second, but related, point is that the algebraic, geometric, and neutral "vehicles" were not purely what they purported to be. For example, the geometric approach appeared to involve a substantial amount of algebra.

My third point of concern lies with the underlying assumption the author makes about the H and HC treatments. On the basis of the result that subjects in treatment H did significantly better than treatment HC subjects on the algebraic posttest, Pereira-Mendoza claims that "... it appears to be more effective to teach heuristics alone than to teach them in combination with the teaching of specific content" (p. 144). However, since ten days were allotted for each of these treatments, it seems reasonable to suggest that treatment H subjects did better than treatment HC subjects simply because more time was spent on teaching heuristics in the H treatment than in the HC treatment. An alternative conclusion could be that students learn the use of certain heuristics better when X amount of time is given to heuristics instruction than when less than X amount of time is given to such instruction.

The lack of clear descriptions of the instructional treatment booklets is an equally serious shortcoming. One difficulty caused by this vagueness is that it is impossible to determine how closely related the "novel" problems comprising the two posttests are to the treatment problems. It seems to me that if the posttest problems were like the treatment problems, the finding that the heuristic groups did better than the "content" group is far from surprising. That is, it is possible that the deck was stacked in favor of the heuristics groups simply because subjects in those two groups had solved problems during instruction that were similar to the test problems. Of course, this may not be the case, but there is no way to know with certainty by reading the report of the research.

There are two final areas of concern to me. These concerns involve the "grading scheme" for the posttests and the conceptualization of the study. Student performance was judged on the basis of their written work only. Consequently only those students who showed enough work on their papers to allow judges to assign scores (a 0-5 scale was used) were included in the data analysis. Although the author realized that this scheme did not allow the use of ANOVA or similar techniques, I wonder if he also recognized the other inherent limitations in his grading scheme. For example, most problem-solving researchers recognize the inadequacy of quantitative data to measure mental processes. Also, the 0-5 scale seems somewhat arbitrary (e.g., why did a subject receive a score of 3 if he or she used analogy only, but a score of 2 if he or she examined cases and looked for a pattern?).

Finally, I believe that instruction-related problem-solving research should not attempt to control the teacher variable as Pereira-Mendoza has done in this study. Problem-solving instruction research is most valuable when the teacher is regarded as an essential factor, not eliminated from consideration.

An important problem was addressed by this study but, due to several flaws in the design and conduct of the research, very little light is shed on a possible solution to the problem. I caution all mathematics educators against using the results of this study to support particular instructional practices.

Frank K. Lester, Jr.

Swafford, Jane O. SEX DIFFERENCES IN FIRST-YEAR ALGEBRA. Journal for Research in Mathematics Education 11: 335-346; November 1980.

Abstract and comments prepared for I.M.E. by ROSS TAYLOR, Minneapolis Public Schools.

1. Purpose

The purpose of this study was to determine whether female and male students with comparable mathematics backgrounds will have comparable achievement patterns in the first-year algebra course. In particular, the study investigated changes in achievement, attitude, and applied problem-solving skills that occur during the course.

2. Rationale

The literature of the '60s and early '70s indicated that sex-related differences in mathematics achievement first began to appear during early adolescence and tended to increase as students progressed through high school. More recently, these differences have been attributed to higher participation by males in high school mathematics courses. The first-year algebra course is crucial because it is generally the first elective course in a college-preparatory sequence. Four studies on sex differences in first-year algebra have shown no male superiority. However, three of these were conducted prior to World War II. This study investigated sex-related differences in algebra in the late 1970s in 17 schools throughout the country.

3. Research Design and Procedures

Subjects

The subjects were 329 female and 294 male students enrolled in a traditional first-year algebra course during the 1976-77 academic year in 17 schools selected across the country on the basis of geographic and community size distribution. The study used data from the control group in the evaluation of a set of experimental first-year algebra materials with an applications orientation. In each school there were two control groups, both taught by the same teacher.

Achievement

Entering mathematics preparation was assessed with the Mathematics Computation Subtest of the Stanford Achievement Test: Advanced Battery, Form A (1973). Algebra achievement was assessed with the Educational Testing Service (ETS) Cooperative Mathematics Test, Algebra I, Form A (1962). Only data from students who took both tests was included in the analysis. An analysis of variance was performed on each test with sex and school used as sources of variance. Individual t tests were conducted for each school by sex.

Attitude

Affective items were drawn from attitude instruments developed for the project. In the fall 19 Likert-type items and one multiple-choice item were used. The usefulness of mathematics was addressed by nine items in the fall and spring, four of which were modified in the spring to read "algebra" instead of "mathematics"; in addition, four new items focusing specifically on algebra were included in the spring. The enjoyment of mathematics was addressed by nine items in the fall and seven in the spring, of which two were repeated, three were modified and two were new. Mathematics as a male domain was addressed by one item in the fall and repeated in the spring.

Data were analyzed by item across schools by sex. Likert-type items were assigned values from 1 to 5 and differences between mean scores were analyzed with t tests. For multiple-choice items, the statistic chi squared was used. For the eight Likert-type repeated items, changes in attitude were analyzed by means of a t test on paired data. Differences in mean change scores from fall to spring by sex were analyzed with t tests.

Consumer problem-solving skills

A pretest and posttest of consumer objectives was developed and administered in the project. Analysis was made of the twenty-one items for which both fall and spring data were available. In the spring, there were two test forms, each of which was administered in half the schools. The chi squared statistic was used to test for each item whether the number of correct and incorrect responses differed significantly by sex in fall and in spring and whether within each group the number changed significantly from fall to spring.

4. Findings

Achievement

No sex-related achievement differences were found either at the beginning of the year or at the end of the first-year algebra course. There was a wide variability in mean achievement levels among the 17 schools which was reflected in significant school effects on both tests. There was no significant sex x school interaction. Individual t tests conducted in each school by sex yielded significant differences ($p < 0.05$) in one school on the arithmetic test and in another on the algebra test, both favoring females.

Attitude

In the fall, the only item that showed a significant difference by sex was the one that stated that mathematics is more for boys than girls, with more boys than girls agreeing. This significant difference was sustained in the spring. Also, in the spring, significantly more boys than girls indicated that algebra is confusing to them and also that they enjoy working word problems. The percentages of girls and boys planning to take another mathematics course increased from 65.8% to 83.6% and from 69.9% to 82.1%, respectively, from fall to spring. Responses on the seven modified items showed no significant difference by sex in either fall or spring. However, scores declined significantly on six of the items for females and on five for males.

Consumer Test Data

In the fall, of 21 items, males performed significantly better on four items and females on one item. In the spring, males performed significantly better on eight items and females on none. From fall to spring, significant gains were made by males on eight items and by females on just four of these same items.

5. Interpretations

Achievement Differences

It seems that females fare as well as, and in some instances better than, males in first-year algebra.

Attitude Differences

In the fall, there were no significant differences between males and females with respect to their attitudes about the enjoyment and usefulness of mathematics. Both groups showed a slight decline in attitudes from fall to spring. In both fall and spring, males stereotyped mathematics as a male domain at a higher level than did females. This finding agreed with a study by Fennema and Sherman reported in 1978. In the spring, males were favored on two items, not repeated from the fall, which referred to the enjoyment of mathematics. This was in contrast to previous studies which indicated sex-related differences with respect to usefulness, but not to liking of mathematics.

Consumer Test Differences

On consumer items, males performed somewhat better than females in the fall and showed more improvement during the year. Eight of the ten items significantly favoring males were multi-step problems. This difference is consistent with data from both NAEP studies. For the subjects in this study, these differences cannot be explained in terms of differential course taking, differential achievement in arithmetic or algebra, or sex bias in the items.

Recommendations

Overall comparability of males and females in achievement and attitude after their first-year course in algebra is reassuring. However, the higher achievement of males on consumer items is a cause for concern. Further research is needed to identify the underlying causes and potential remedies for these differences, particularly with respect to multi-step applied problems.

Abstractor's Comments

This study makes a valuable contribution to the growing body of knowledge about sex-related differences in achievement in high school mathematics. The study appears to have been carefully designed and well executed. It confirmed the results of previous studies that have consistently shown no male superiority in achievement in first-year algebra. On the other hand, it confirmed sex-related differences on consumer items that had previously been identified in NAEP studies. This study clearly points to the need for more information about sex-related differences in solving multi-step applied problems.

The most reassuring finding of the study was the marked increase from fall to spring in the number of students who planned to take a succeeding mathematics course (increases of approximately 18% for girls and 12% for boys). Similar studies for succeeding courses could provide valuable information about possible differentiated course-taking and achievement.

The idea of using data from control groups of another study to produce these findings is an excellent one. The wide variability of mean achievement from school to school leads one to believe that more information could be gained from the data. For example, do geography or community size account for some of these differences? Are the achievement patterns by geographical region and community size similar to the patterns found in the NAEP studies? This information could be useful on a national scale to target efforts to produce desired increases in achievement.

A reader of the report of this study might like some additional information on the distribution of the 17 schools by geography and by community size. Apparently the requirement of two algebra classes for each teacher eliminated small rural schools from the study. Furthermore, no information is given about the grade levels and ages of the students. Can we assume that nearly all of the boys and girls were ninth graders or at least that there was no difference in age level and grade level patterns between the boys and girls in the study? Some information about the administration of the instruments used in the study would have been helpful. It does not appear that the investigators could have personally administered the instruments in 17 schools scattered throughout the country. Then what provisions were made to insure uniform administration procedures?

In general, the data from the study were clearly presented in tabular form. However, Table 3 could have been clarified to indicate whether higher scores indicated greater agreement or disagreement with the specific items from the opinion survey. Nevertheless, on the whole the report appears to be a clear presentation of a carefully conducted study that provided useful information on an important topic.

Swafford, Jane O. and Kepner, Henry S. THE EVALUATION OF AN APPLICATION-ORIENTED FIRST-YEAR ALGEBRA PROGRAM. Journal for Research in Mathematics Education 11: 190-201; May 1980.

Abstract and comments prepared for I.M.E. by WILLIAM M. FITZGERALD, Michigan State University.

1. Purpose

In 1974, the National Science Foundation funded a First Year Algebra Development Project directed by Zalman Usiskin of the University of Chicago. A set of materials entitled Algebra Through Applications resulted.

During the 1976-77 school year, the NSF sponsored a field evaluation of those materials in which the goals were:

a) to evaluate the materials in typical classrooms in schools representative of a broad spectrum of the nation's schools,
b) to evaluate the extent to which students using the materials understand the concepts considered unique to these materials (as well as the concepts considered standard in first-year algebra) when compared to other first-year algebra students,
c) to evaluate the extent to which student attitudes about the enjoyment and usefulness of mathematics are affected through the use of these materials,
d) to evaluate the extent to which an application approach helps in solving real-life problems,
e) to evaluate the appropriateness of the reading level of the materials, and
f) to determine the difficulties, if any, of implementing the experimental materials in the school curriculum. (p. 190)

2. Rationale

In these materials, the usual skills and concepts are developed through applications and models rather than from the field properties. The traditional skills associated with first-year algebra are presented, with the exception of the factoring of polynomials, fractional expressions and simplification, and artificial word problems. In their place, greater attention is given to operations, linear expressions, sentence solving, and problems arising from real situations. Elementary notations from probability and statistics are integrated into the course. (p. 190)

3. Research Design and Procedures

"Twenty schools throughout the U.S. were selected from volunteer schools to provide a balance among locations and community types." Each school submitted the names of two equally capable teachers, one of whom was selected at random to be the experimental teacher. "The resulting two groups of teachers were comparable in terms of education, experience, age, and sex distribution." Each teacher was assigned two algebra classes; students were randomly assigned to the four classes in each school. In all, 2,455 students participated.

The experimental classes used the materials provided free by the project. Except for a teacher's guide, no guidance or in-service was provided for the experimental teachers. Each control teacher used the "usual" algebra materials.

Four tests were administered by the teachers in Fall 1976: the Mathematics Computation Subtest of the Stanford Achievement Test; the ETS Cooperative Mathematics Test: Algebra I; a project-developed 25-item Opinion Survey; and a project-developed 28-item Consumer Test. In Spring 1977, four tests were also administered: the ETS Cooperative Mathematics Test: Algebra I; a project-developed First-Year Algebra Test; a modified Opinion Survey; and a shortened Consumer Test.

The First-Year Algebra Test was developed to measure achievement on objectives of the traditional course and the experimental materials not measured by the ETS test. Reliability estimates (Kuder-Richardson Formula 21) for the 33-item test were 0.79 for the experimental group and 0.77 for the control group.

The Consumer Test involved selected consumer problem-solving skills; the problems could be solved without algebra. The Fall test contained 28 items; the Spring test contained 21 items, allocated to two 10-minute tests, each administered in half the schools.

"The Opinion Survey was developed to monitor changes in attitudes relative to the enjoyment, usefulness, and feedback from students on their textbooks." The Fall form contained 24 Likert-type items and 1 multiple-choice item. Sixteen of these items were on the Spring form, with 7 modified to read "algebra" instead of "mathematics"; 9 new items were added.

Data were used from 17 schools, which included 679 students in experimental classes and 611 students in control classes. A matched pair t-statistic was computed for each of the 17 matched pairs for the four achievement measures. Then, because of the wide variation among schools, a separate t-test analysis was undertaken for each of the 17 schools.

Further analysis was undertaken looking for significant differences between the experimental and control group on an item-by-item basis for both the spring ETS Test and the F.Y.A.T.

The attitude data were analyzed by a t-test for the Likert-type items and a chi-square statistic for the multiple-choice items. A chi-square statistic was also used to analyze the consumer test data. Readability was measured with two readability formulas, teacher judgment, and an information-content-level formula.

4. <u>Findings</u>

No significant differences were found between the two treatment groups on any of the four achievement measures when the 17 pairs of classes were matched. When the treatment groups were matched with schools, nine control groups were significantly higher on the spring ETS test and nine experimental groups were significantly higher on the F.Y.A.T.

In the item-by-item analysis, the control group was significantly higher on 16 of 40 items on the ETS Test while the experimental group was significantly higher on 13 of 33 items and significantly lower on 3 of 33 items on the F.Y.A.T.

Eight items from the attitude data were significantly different, favoring the experimental group in five cases and the control group in three cases. Over the school year the attitude of the students decline on 9 of 15 items for the experimental group and on 7 of 15 items for the control group.

In the consumer test data, the experimental group was higher in 1 of 21 items in the fall and in 2 of 21 items in the spring. Over the school year the experimental group gained on 13 items while the control group gained on 10 items.

There were no significant differences in the readability of the experimental materials and two widely used first-year algebra texts.

5. Interpretations

"These data suggest that the experimental materials can be used successfully in a variety of school settings." (p. 198)

The control group performed significantly better on some traditional algebra skills also included in the experimental materials; "thus, there is an apparent weakness in the experimental materials in...the development of traditional algebraic skills." (p. 198)

"The experimental group performed significantly better on items measuring concepts unique to the experimental materials. Since many teachers...either failed to reach or omitted some of the topics unique to the materials, the performance of the experimental group speaks well of the effectiveness of the integration of applications and probability throughout the experimental textbook." (p. 198)

Attitude

"Perhaps algebra is viewed as less important in everyday life, less interesting, and harder to learn than mathematics in general. It would seem that the study of algebra, whether through an applications approach or not, does not enhance the students' view of the value of mathematics for the real world." (p. 199)

Support is noted "for the integration of applications into each lesson is more effective than their isolation in separate lessons" and "the development of algebra out of real-world problems." (p. 199)

Transfer to Applied Problem Solving

"The study provides evidence that consumer problem-solving skills would be improved with wider attention to real-life applications ...[and that] such skills should be explicitly taught." (p. 199)

Textbook Readability

"The data do not indicate that the reading in the experimental materials should be reduced or simplified." (p. 199)

Implementability

"...the experimental materials can be used effectively in many situations." (p. 200)

Evaluation of Experimental Materials

"Field evaluations of experimental materials should include reasonable inservice or other logistic support for the experimental teachers to assure that the content is presented accurately and in the spirit in which it was developed. At the same time, evaluation techniques need to be refined in order to assure that the support for the experimental group balances, rather than outweighs, tradition." (p. 201)

Abstractor's Comments

What you have just read is an abstract of an abstract because the article reviewed in J.R.M.E. is greatly reduced from the Report of the Evaluation of "Algebra Through Applications" available through ERIC (Document Number ED 110 336).

Most of the interpretations in this abstract are direct quotes, but represent much less than the entire interpretation and are therefore somewhat misrepresentative.

The description of the study is extremely well written and describes the specifics of the evaluation very well. Many details had to be omitted due to space constraints. This abstractor had the opportunity to get a few fleeting glances of this evaluation as it was taking place and was impressed with the high degree of professional effort expended in the project. One can have a great amount of confidence in the statistical tests, techniques, and procedures which were used.

My abstractor gudelines appear to provide considerable license to introduce personal bias and feeble reminiscences. My feeling after reading the report in detail is that we still have not learned to ask the right questions in evaluating curriculum development projects.

In 1959 when I was an SMSG junior high school tryout teacher and new graduate student, my mentor and I requested some modest funds to compare the effects of SMSG materials to standard junior high school texts. When we approached Ed Begle about the request he stated that SMSG was really more interested in improving curriculum than in evaluating it. I thought, how naive! He gave us the money and we didn't find out anything.

By the time Ed died, he and I had switched positions.

A project such as Algebra Through Applications is funded because someone has an idea for improving the curriculum in some significant way. If we learned anything from SMSG, it was that the teacher is key and new printed materials can't be expected to have many observable effects. To attempt to evaluate these materials without intensive inservice for the teachers (as the authors pointed out) and using time-worn statistical models (appropriate for agriculture) is to do a disservice to the original creative idea.

Threadgill-Sowder, Judith A. and Juilfs, Patricia A. MANIPULATIVE VERSUS SYMBOLIC APPROACHES TO TEACHING LOGICAL CONNECTIVES IN JUNIOR HIGH SCHOOL: AN APTITUDE X TREATMENT INTERACTION STUDY. Journal for Research in Mathematics Education 11: 367-374; November 1980.

Abstract and comments prepared for I.M.E. by BOYD HOLTAN and MARY ELLEN KOMOROWSKI, West Virginia University.

1. Purpose

To examine interactive effects between mathematical achievement and manipulative versus symbolic instruction with junior high school students.

2. Rationale

It is commonly assumed that a concrete or manipulative approach to instruction in mathematics is generally superior to a nonmanipulative, abstract approach. However, as grade level increases, the number of studies supporting a manipulative approach decreases and the results are inconclusive at the junior high school level. One suspects that for at least some students a concrete manipulative approach may be more productive and that an interactive effect may exist. Junior high school students who are lower achievers in mathematics may have a greater need for concrete materials, while high-achieving students may be learning well with a symbolic approach. An attribute-treatment-interaction study was conducted to investigate the relationship.

3. Research Design and Procedures

The subjects were 147 seventh-grade junior high school students. The students were randomly assigned to one of two treatment groups and a control group. The two instructional treatments used a new topic for the students, logical connectives (conjunction, disjunction, and negation). One of the treatments used a manipulative format with color-coded cards and attribute blocks while the other treatment was symbolic, with workbooks and paper-and-pencil exercises on the same topic content. The third or control group studied a different topic, traversability of networks.

The treatments continued for three 40-minute periods but included 25 minutes of testing in the third period. To ensure consistency in presentation and time of instruction, the two treatments were videotaped.

The criterion measures were a 25-question multiple-choice achievement posttest and a 20-item transfer test. The aptitude measures were the 48-item Mathematics Concepts Test and the 32-item Mathematics Problem Solving Test from the Canadian Test of Basic Skills. The aptitude measures were completed about one month before the treatments.

The treatment effectiveness was tested by using one-way analysis of variance on the achievement and transfer posttest scores of the three groups (two treatments and control). Interaction effects were investigated by using A-T regression analysis of the scores of the two treatment groups on the achievement and retention posttest and the results of the mathematics concepts and problem-solving tests as aptitude measures.

4. Findings

The ANOVA indicated significant differences between treatment and control group means for both the achievement ($F\ (2,144) = 31.66$, $p < .01$) and transfer ($F\ (2,144) = 11.85$, $p < .05$) test scores. The control means were significantly lower than the manipulative treatment and symbolic treatment group means. However, manipulative and symbolic group achievement means did not differ significantly for either the achievement or transfer criterion measures.

A significant interaction was found between Mathematics Concepts scores and treatment effects ($F\ (1,93) = 5.25$, $p = .024$). Regression equations for each treatment group were calculated and plotted. The intersection of the lines was within the range of scores and the interaction was interpreted as disordinal (see Figure 1).

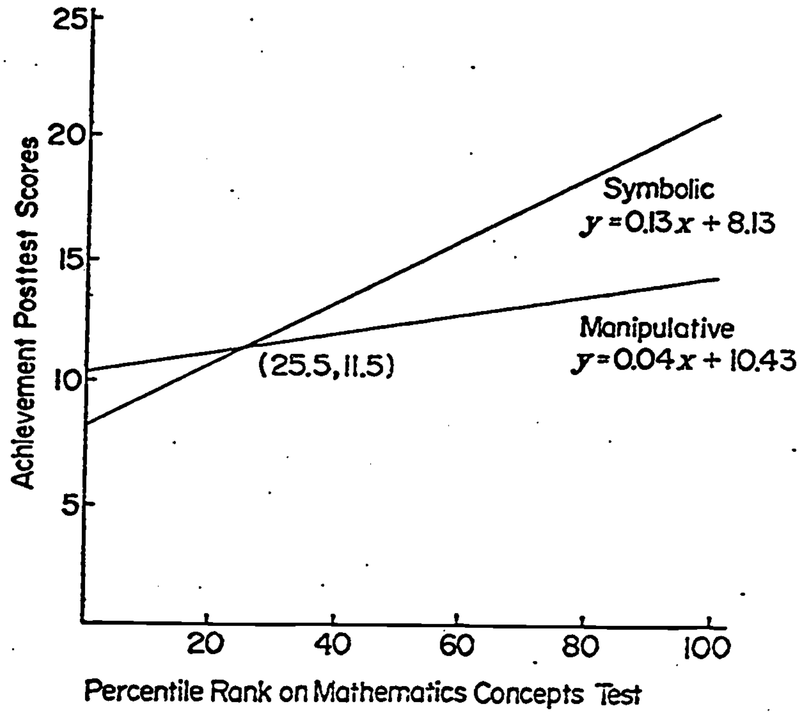


Figure 1. Interaction of Mathematics Concepts test with achievement posttest.

(p. 371)

A similar interaction was found between Mathematics Problem Solving scores and treatment effects (F (1,93) = 5.69, p = .019) (see Figure 2).

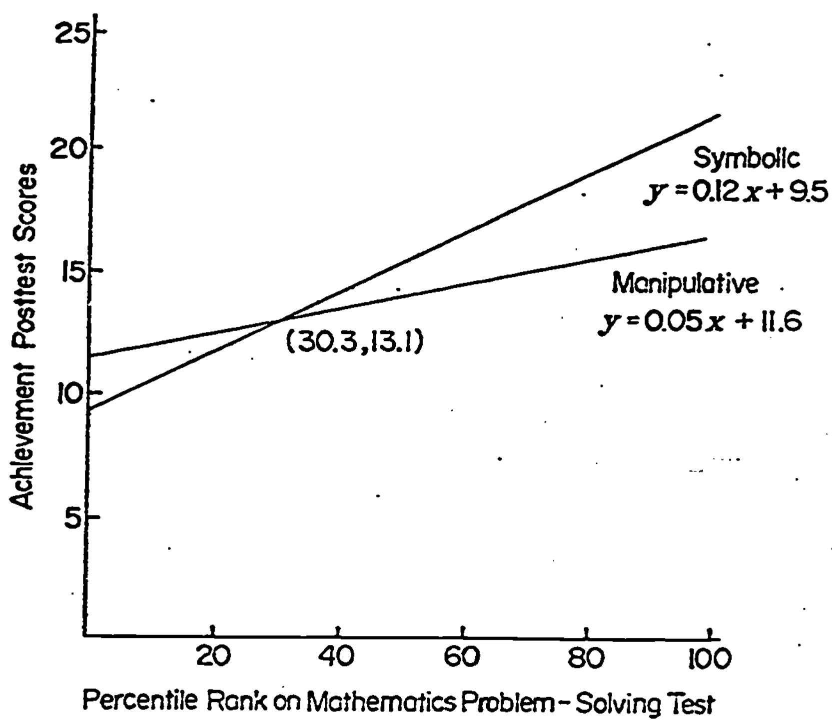


Figure 2. Interaction of Mathematics Problem Solving test with achievement posttest.

(p. 372)

No significant interactions were found when transfer posttest scores were regressed on the aptitude measure.

5. Interpretations

The ANOVA results of no significant difference between manipulative and symbolic group means was expected. The difference of these two group means frcm the control group means indicate that the instructional treatments did provide a learning experience.

Results of the regression interaction analysis show that achievement in mathematics can significantly interact with manipulative and symbolic modes of instruction. Students receiving low scores on the Mathematics Concepts and Mathematical Problem Solving aptitude tests received higher scores on the achievement posttest when instruction included manipulative materials, while students with high concept and problem-solving scores found the symbolic approach more beneficial. The first half supports common assumptions about manipulatives for lower aptitude students, but the second half was unexpected. The researchers hypothesized that the more able students were accustomed to and could process symbolic instruction effectively, and possibly manipulatives were distracting to them.

The lack of interaction with treatments and transfer criterion measure was thought to be due to the type of test items in the transfer test.

Abstractor's Comments

Researchers are increasingly reporting studies which support aptitude-treatment-interaction findings, and this study adds to that body of information. Cronbach and Snow described this area of research as "wandering among the foothills" of A-T-I knowledge, so the information is welcomed.

The results found for the use of manipulatives with lower ability students are congruent to the notion that for unsuccessful students an alternate approach is helpful. Since the higher ability students may have usually benn successful previously with symbolic instruction, the finding of the success of this method for them should not be unexpected. The success of the more able students may also be related to the concept of "crystallized" ability and its relation to previous learning that has been investigated in earlier A-T-I studies.

The study had a sufficient number of subjects and used a novel instruction treatment topic that produced achievement. Like many A-T-I studies, it had a rather short treatment time -- 3 periods of 40 minutes with 25 minutes of the last period for testing. The effect of the time on the study results is not known since the relationship of treatment time and A-T-I is not well known.

This study has provided additional research information on attempts to uncover A-T-I effects that many teachers believe to exist. Hopefully, sufficient information will eventually be obtained to be of help in instructional theory development.

Wheatley, Charlotte L. CALCULATOR USE AND PROBLEM-SOLVING PERFORMANCE. Journal for Research in Mathematics Education 11: 323-334; November 1980.

Abstract and comments prepared for I.M.E. by WALTER SZETELA, University of British Columbia.

1. Purpose

The purpose of this study was to compare problem-solving performance of elementary school pupils using calculators with that of pupils not using calculators with respect to: (a) range of problem-solving processes used, (b) number of computational errors, and (c) number of problems solved.

2. Rationale

The author cites studies in which differences in tests of concepts, reasoning, and problem solving favored calculator groups. It is asserted that in problem solving, when pupils must perform lengthy computations, development of effective problem-solving heuristics may be inhibited. Thus, by removing the computational barrier, calculators may facilitate problem solving. The author also cites Suydam, who in her 1976 NSF report observes that "all of the research about calculator effects on problem solving had the common element that the calculator was an adjunct to units on problem solving - it was not incorporated into a specific problem-solving strategy."

3. Research Design and Procedures

Subjects were all 46 sixth graders in an elementary school in a midwestern university town. Percentiles on the Iowa Test of Basic Skills were "above average." Percentiles ranged from 33 to 99, with 56% above the 90th percentile. Pupils were "randomly assigned by the principal to one of two classes at the beginning of the school year." Both the calculator and non-calculator groups studied a unit on operations with decimal fractions "with emphasis on application." In both classes techniques of problem-solving were taught as part of the daily schedule. Each day both groups discussed one or more problems including different strategies possible. Among the 14 techniques of solving problems taught were: make a list, look for patterns, make a reasonable estimate, draw a picture, write mathematical sentences, check work, retrace steps. One teacher taught both groups for 6 weeks. The same problems were done in both groups. The calculator group did assignments as well as classwork using calculators.

After six weeks each child was interviewed and given five problems to solve. Stated criteria for the problems were (a) appropriate difficulty level; (b) solvability in more than one way possible; (c) computation, usually multiplication or division, required. The problems had been developed over a one-and-one-half year period, including careful analysis of problems from a pilot study. The interviewer followed a fixed protocol for presentations and questioning. Interviews were tape-recorded. A second person made notes to aid interpretation of protocols. Processes used by subjects were identified from the interview transcripts. A checklist coding system modeled after Days (1978) and Kilpatrick (1968) was used to tally 10 selected processes to be analyzed such as guessing, estimating, checking, etc. Measures were also taken for computational errors, total time each student worked on problems, and a "production score." On a given problem, a production score of 1 was given if the only error was in computation. Following is an example from the set of five problems:

> 12 sacks of corn and 15 sacks of beans weigh 2835 pounds. Each sack weighs the same. Each sack of corn weighs 130 pounds. What is the weight of each sack of beans?

4. Findings

On the 10 processes used in problem solving which were analyzed, the calculator group used a total of 152 compared to 104 for the noncalculator group. The difference was significant ($t = 4.11$, $p < .01$). The calculator group made fewer computational errors (12 compared to 31, $t = 2.17$, $p < .01$). Differences on production scores and time-on-task were not significant.

With reference to a table of results on particular problem-solving processes, the author states that "It should be noted that the number of bright ideas in the calculator group was seven compared to zero for the noncalculator group." She also notes that subjects in the calculator group estimated more (10 to 6), and retraced their problem-solving steps more often (17 to 5). She makes no special mention of the calculator group's predominance in using unexpressed equations (49 to 30). For each process, the maximum possible score was 105 in the calculator group (21 subjects, 5 problems) and 115 in the noncalculator group (23 subjects, 5 problems).

5. Interpretations

The author concludes that calculators allowed the students to focus on problem-solving approaches and that calculators had a positive influence on children's problem-solving performance. Although time-on-task for the two groups did not differ, the interviewer reported that the calculator group spent more time analyzing, and the noncalculator group spent more time computing. From scores on the Iowa Test of Basic Skills, the author suggests that subjects in the noncalculator group "may have had higher ability." Evidence to support the use of calculators in problem solving is also offered through the teacher's report that "the calculator group solved 10% more problems daily than the noncalculator group," and that the calculator group had more confidence, were more motivated to solve problems, and enjoyed the calculator experience. Furthermore, the interview team reported that "pupils seemed more confident using the calculator, exhibited more exploratory behaviors in problem solving, spent more time attacking problems and less time computing." The author cites as limitations of the study the use of students of above average ability, small sample size, short duration, and the use of a single teacher for both groups.

Abstractor's Comments

The author is commended for undertaking a study designed to explore more carefully advantages of calculators, instead of using calculators simply as "an adjunct to a unit on problem solving." This type of investigation, although more difficult, has greater potential for uncovering ideas for more effective use of calculators. Without such studies, entrenchment in a paper-and-pencil curriculum may remain even longer. Another commendable attribute of the study was the conduct of a pilot study which must have provided valuable practice and information on how pupils vocalize their thinking, and how best to record and observe such vocalization, and must have helped in the choice and refinement of suitable problems for the main study. Tape-recorded protocols together with a second person taking notes would ensure greater reliability in identification and enumeration of problem-solving processes. The results of the study do offer some support for the hypothesis that calculators facilitate problem solving among children. However, the results were hardly dramatic, and in terms of number of problems solved, and also time spent on problems, calculators were not a significant factor. The report itself lacks some clarity and includes some questionable claims for support of calculator use in problem solving. The reader is left wondering or forced to make some assumptions. Following are some concerns about clarity and questionable support:

1. It is stated that pupils were randomly assigned to calculator and noncalculator groups at the beginning of the year by the principal. It is then stated that the treatment took place over a period of 6 weeks. Are we to assume that the treatment took place at the beginning of the school year? If so, it should have been clearly stated. If not, intervening experiences before treatment would cloud the purity of the initial random assignment.

2. In describing the subjects, the author gives a range of percentile scores and the number of subjects above the 90th percentile. Such figures can be misleading. A mean percentile for each group would be more accurately descriptive.

3. An apparently important measure, the production score, is poorly defined. Scoring also was unclear. Was a score of either zero or 1 given? We can only guess. My guess is zero or 1, but the reader should not be placed in a guessing situation.

4. If a pupil's production score on a problem was zero or 1, the matter of partial credit becomes a concern. The scoring of problems as right or wrong seems inappropriate.

5. The calculator group is reported to have used more unexpressed equations than the noncalculator group (49 to 30). If these equations are not explicitly stated, how reliable can the enumeration and identification of this process be? Would it not have been more appropriate to measure expressed equations?

6. It is reported that the interviewer observed calculator subjects doing more analyzing and less computing than noncalculator subjects. Yet the production scores were not significantly different. It would be useful to offer reasons or conjectures why the more productive type of activity failed to be more fruitful in terms of actual solutions.

7. What is classified as a bright idea? There were only 7 on about 200 problems attempted.

8. In the discussion several statements are given to support the case for calculators for which any strong numerical basis is lacking. How reliable is a teacher statement that the calculator group solved 10% more problems daily than the noncalculator group, had more confidence attacking problems, were more motivated? Similarly, the interview team's statements that pupils using calculators "seemed to be more confident" and "exhibited more exploratory behaviors" may be unreliable judgments.

9. The author makes special mention of the superiority of the calculator group for several problem-solving processes. However, to state that the calculator group estimated 10 times compared to 6 times for the noncalculator group, when each group had about 100 opportunities to estimate, serves to suggest equality rather than difference.

The author does point out limitations of the study including the point that the results may have been influenced by the teaching style of a single teacher. I would contend that differences between teaching styles of two teachers are likely to be greater than different styles in different settings for one teacher.

The concerns noted with respect to clarity should not obscure the fact that this study aims at breaking new ground and should be followed by similar studies which will point the way more clearly to more productive and efficient use of calculators in teaching.

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