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ABSTRACT

The purpose of this investigation was to determine the effects of training preservice elementary school teachers to use Bloom's Mastery Teaching Strategy. Data were collected and analyzed to determine the effectiveness of the training in three areas: a) affective change among the trainees with regard to tests, b) the ability of the teachers to apply the skills they learned in an actual school-teaching situation, and c) the effects of the training on the achievement and attitude of elementary school pupils. The results of the study show that because of the training a) teachers registered a more positive attitude toward the use of tests in evaluation; b) teachers could effectively implement mastery teaching strategies in the classroom; and c) pupils show no significant difference in achievement or attitude measures, although this may be due to the fact that the same teacher instructed both the control and experimental groups using different strategies and may have subtly and unknowingly utilized the experimental strategy while teaching the control group. (Author/HMD)

The Effects of Training Preservice Teachers to Use Bloom's Mastery Teaching Strategy: A Process-Product Study*

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One of the goals of most teacher training institutions is the preparation of teachers who can establish and manage classrooms in ways that lead to maximal learning by all pupils. Bloom (1968) has suggested that under certain instructional strategies nearly all students in a typical classroom can reach the high levels of achievement usually attained by a few. This "Mastery Learning Hypothesis" by Bloom has elicited considerable research among educators (Block, 1971, 1973a, 1973b; Bloom, Hastings, and Madaus, 1971; Burrows, 1973; Collins, 1971; Fiel, 1972; Kersh, 1971; Madaus and Airasian, 1970; Miller and Miller, 1970; Okey, 1973; Okey and Ciesla, 1972a, 1973).

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The paper summarizes a dissertation written by the first author and directed by the second author. Copies of most materials and instruments referred to in this paper are found in that thesis produced at Indiana University in 1973 and titled: "The Effects of Training Preservice Teachers to Use Bloom's Mastery Teaching Strategy on the Achievement and Attitude of Elementary School Pupils".

The teaching strategy suggested by Bloom to enable most students to attain a predetermined standard of achievement in any given course involves supplementing regular group instruction with diagnostic testing procedures, and then using the diagnostic data as a basis for determining subsequent instruction. An instructor using a mastery teaching strategy would not wait until the end of a unit to administer a test, but instead test students as soon as they have completed short segments of instruction to locate learning deficiencies.

At least two factors contribute to the current popularity of mastery learning: its idealistic appeal and the favorable research supporting it. As an indication of its popularity, it has been estimated that more than 200,000 pupils in over 500 American public schools are being taught by teachers who are using a mastery teaching strategy (Block, 1973a; Harrisberger, 1971).

The review of process-product research by Rosenshine and Furst (1971) helps to explain why one might expect that teachers who use a mastery teaching strategy would find marked achievement gains among their pupils. Four of the five teaching behavior variables they identify as having the strongest correlation with pupil achievement typically comprise a mastery teaching strategy. The variables are:

1. Clarity: the careful organization and presentation of instruction;

2. Variability: the variety of instructional materials used by teachers;
3. Task-orientation: the teacher's businesslike behavior and orientation toward pupil achievement;
4. Student opportunity to learn criterion material: the teacher's orientation toward cognitive classroom activities designed to enhance student learning.

The fifth strong variable identified by Rosenshine and Furst, teacher enthusiasm, though not an essential component of a mastery teaching strategy, is a behavior that one could infer to be exhibited by teachers who have committed themselves to implementing a mastery strategy in their classrooms.

Nevertheless, two serious deficiencies are associated with the present state of the art of mastery learning. First, much of mastery learning research has been quaisi-experimental, i.e., the research has been imperfect by most experimental research standards. Block, who has compiled much of the research on mastery learning, claims that most of this research has been conducted by classroom teachers under non-controlled conditions (Block, 1971, 1973a, 1973b). Second, although many teachers are attempting to implement a mastery learning plan in their classrooms, they are doing so on their own and often without adequate prerequisite skills for such an undertaking. Furthermore, little is known about the effectiveness of programs specifically designed to train teachers toward this competency.

Therefore, the purpose of the present investigation was to determine the effects of training preservice elementary school teachers to use Bloom's mastery teaching strategy. Data were collected and analyzed to determine the effectiveness of the training in three areas of concern. First, an affective change among the teachers who received the training was examined. Second, the ability of the teachers to apply the skills they learned in an actual training situation was assessed. Finally, the effects of the training on the achievement and attitude of elementary school pupils were studied.

PARTICIPANTS

Preservice Teachers

Eighty-four preservice elementary school teachers participated in one or more phases of the investigation. These subjects were college seniors enrolled in their final semester of the Professional Year Program at Indiana University. During that semester these teachers received methods instruction from the School of Education staff and practiced teaching under the supervision of cooperating inservice teachers. At the beginning of both semesters during the Professional Year each student was randomly assigned to a participating inservice teacher in one of four elementary schools in the Monroe County Community School System.

Assignments of students participating in the Professional Year Program to one of the two 42 member sections of the

program were made in August of 1972. Every other name appearing on an alphabetized listing of Professional Year Students comprised one section and the other half comprised the second section.

During one week of their math methods course all students in one section of the Professional Year Program were trained to use Bloom's mastery teaching strategy. Teaching For Mastery (Okey and Ciesla, 1972a), a self-instructional teacher training module, was used as the training vehicle. Students in the other section of the Professional Year Program were not given any instruction on mastery teaching strategies and served as the control group for the study.

Eight of the prospective teachers who studied the training module had been assigned to practice teaching third and fourth grade classes at one elementary school. These eight subjects were scheduled to participate in the phase of the study that examined the effects of the training upon elementary school pupils.

Observers

The eight inservice third and fourth grade teachers who supervised the eight preservice third and fourth grade teachers at the elementary school were hired as observers in the investigation. The observers were trained to compare specified behaviors of teachers and pupils under the two experimental

conditions of the investigation. None of the observers was assigned to observe her own class of pupils or the preservice teacher she supervised.

Pupils

The pupils participating in the present investigation were 84 third grade and 110 fourth grade students. The pupils comprised three third grade and four fourth grade classes at an elementary school in Monroe County, Indiana. Third and fourth grade classes were used in the investigation because the study was an extension of a pilot study (Okey and Ciesla, 1973) using the intermediate elementary school population.

The pupils participating in the present study were a representative sample of the population of elementary school students. The mean I.Q. score of the third grade pupils on the Third Edition of the Lorge Thorndike Intelligence Tests was 98.0. The mean composite score on Form Three of the Iowa Tests of Basic Skills placed these third grade students in the forty-fourth percentile nationally. Both tests were administered in October of 1972.

The mean I.Q. score of the fourth grade pupils on the Third Edition of the Lorge Thorndike Intelligence Tests was 98.5. The mean composite score on Form Three of the Iowa Tests of Basic Skills placed the fourth grade students in the forty-fourth percentile nationally. Both tests were administered in October of 1971 at which time these pupils were in the third grade.

On the arithmetic skills subtest of the Iowa Tests of Basic Skills the fourth grade pupils participating in the study had a mean national percentile rank of 56, whereas the mean percentile rank for the third grade pupils was 45.

PROCEDURES

Training the Preservice Teachers

Two weeks prior to the phase of the study that involved pupil participation, the 42 prospective teachers in one section of the Professional Year Program began the five-hour self-instructional training module called Teaching For Mastery. The materials in the training program consisted of tape-slide and paper and pencil exercises. Frequent opportunities for practice with feedback were given in the program, and self-tests with answers were included for each of the six sections into which the module was divided. A total of 22 outcomes were stated in the program that ranged from sequencing objectives, to constructing diagnostic tests, to selecting alternative instruction for unsuccessful students. The overall goal of the training package was to teach teachers to implement a five-step plan for increasing the achievement of their pupils. The plan is outlined in Figure 1.

Develop objectives for a unit	Develop evaluation measures	Teach	Identify learning difficulties	Reteach & retest as needed
(1)	(2)	(3)	(4)	(5)

Figure 1. Five-step mastery teaching plan

The 42 students in the treatment group section of the Professional Year Program completed all six sections of Teaching For Mastery independently. They were given class time to do sections one and two; they did sections three and four outside of class; and they completed sections five and six during the following class period.

In previous use of Teaching For Mastery with a group of 21 inservice elementary school teachers it was found that 18 of the 22 objectives in the program were achieved by at least 80 percent of the teachers (Okey and Ciesla, 1972b). To determine how successful the eight participating preservice third and fourth grade teachers were on the cognitive outcomes of the training program their self-tests over the six sections of the module were examined. It was found that 19 of 22 objectives were mastered by at least 87 percent of this group. The investigators inferred that the training was successful and that the teachers were prepared to practice their newly acquired skills in a classroom setting.

Okey (1973) found that a change in the attitudes of teachers toward testing and diagnostic teaching was correlated with their completion of the Teaching For Mastery module. Okey administered a 22 item attitude measure to each of 20 teachers before and after they studied the Teaching For Mastery program and found that the difference in attitude scores between the pretest and the posttest was highly significant. The reliability coefficient of the instrument was 0.58 by the test-retest method.

To determine whether studying Teaching For Mastery caused an attitude change among the preservice teachers involved in the present investigation the following experiment was conducted. The attitude measure was administered to each of the 42 preservice teachers as a pretest immediately before they began the training module and as a posttest one week later, at which time they had completed the module. During the same week, the instrument was also administered to the 42 students in the other section of the Professional Year Program (control group) and readministered one week later with no intervening study of the Teaching For Mastery module.

The 22 items on the attitude measure were scored by assigning values to the five-point Likert scale. Responses favoring testing and formative evaluation were given a value of five; responses that disfavored testing and formative evaluation were given a value of one. Scores for each student teacher at both administrations were obtained by summing the point value of the responses for the 22 items. The maximum and minimum possible scores were 110 and 22, respectively.

Due to absenteeism only 31 treatment group subjects and 31 control group subjects completed both the pretest and the posttest. The mean scores of the two groups for both administrations of the attitude measure are given in Table 1.

TABLE 1

Summary of the Pretest and Posttest Scores on the Teacher Attitude Toward Testing Measure

	Group	Number of subjects	Mean	Standard Deviation
Pretest	Treatment	31	79.7	4.8
	Control	31	78.5	4.8
Posttest	Treatment	31	87.5	7.6
	Control	31	79.9	5.2

To determine whether scores from the treatment and control groups differed significantly on the pretest, an analysis of variance was computed (Dixon, 1970). The results of the analysis are summarized in Table 2.

TABLE 2

Summary of the Completely Randomized Design Analysis of Variance for the Teacher Attitude Toward Testing Pretest

Source of Variation	df	$\overline{MS}$	F
Between Groups	1	24.53	1.07
Within Groups	60	22.86	
Total	61		

The computed value of F does not exceed that required for significance at the .05 level, and, therefore, the hypothesis that there was no significant difference in scores on the attitude measure between treatment and control groups prior to treatment was not rejected. In other words, prior to studying the materials on mastery teaching, the attitudes of the treatment and control groups toward testing and diagnostic teaching were statistically indistinguishable.

To determine whether scores from the treatment group and scores from the control group differed significantly on the Teacher Attitude Toward Testing Posttest, an analysis of variance of the scores was computed (Dixon, 1970). The results of the analysis are summarized in Table 3.

TABLE 3

Summary of the Completely Randomized Design Analysis of Variance for the Teacher Attitude Toward Testing Posttest

Source of Variation	df	MS	F
Between Groups	1	905.95	21.40*
Within Groups	60	42.32	
Total	61		

*$p < .001$

The computed F value exceeds that required for significance at the .001 level. The hypothesis that there was no significant difference in scores on the attitude measure between treatment and control groups following treatment was rejected with confidence.

The investigators concluded that studying the Teaching for Mastery module caused the preservice teachers in the treatment group to express more favorable attitudes toward testing and formative evaluation than they had prior to studying the module. Since mastery teaching strategies rely on the use of frequent diagnostic testing, producing favorable attitudes toward testing among teachers trained to implement a mastery teaching strategy becomes an important goal. The results of the experiment support the use of the module to attain that goal.

Preparing the Preservice Teachers to Teach the Experimental Unit

Upon completion of the training module, the eight preservice teachers assigned to third and fourth grade classes at the elementary school were given one week to prepare to teach the experimental unit. Each teacher was supplied with the items described below for use in teaching the unit on fractions.

1. A copy of the teacher's edition of Elementary School Mathematics Book 3 (Addison-Wesley, 1968) and sufficient copies of the pupil's edition of the textbook so that each pupil would have one copy available during the instructional periods. Chapter 10 of the textbook, titled Fractions, contained instructional materials appropriate to the objectives for the unit.

The fourth grade pupils participating in the investigation had not used Chapter 10 during their arithmetic classes the previous year. The third grade pupils participating in the investigation had not yet reached Chapter 10 in their arithmetic instruction of the present year. Therefore, the unit selected for use in the study appropriately fit the arithmetic curriculum of both grade levels at the elementary school, and it allowed the pupils and teachers to use the same textbooks they were accustomed to using.

2. A list of 14 performance objectives for the experimental unit. The teachers were told that the achievement of the pupils they taught would be measured at the completion of the unit through a criterion test based on the 14 objectives.

3. Multiple copies of diagnostic tests for each of the 14 performance objectives. The tests were for use by the teachers in conducting formative evaluations of pupils taught under the mastery strategy. Three diagnostic tests were provided for each objective.

4. A list of the two groups of pupils they would be instructing. Group One was specified for instruction involving the mastery strategy, and Group Two was specified for instruction not involving the mastery strategy. The two groups were formed by taking the class lists of pupils in each participating third and fourth grade classroom and randomly assigning half the pupils within each class to each group using a table of random digits (Dayton, 1970).

5. A copy of the protocol for the experimental unit (Appendix A). The protocol operationally defined the two strategies that the teachers would exercise in teaching the experimental unit. The protocol was discussed at length with the teachers to insure that all teachers understood the behaviors associated with each strategy. The essential difference between the two strategies was that in the mastery strategy the teachers were to use diagnostic tests to identify learning difficulties and then to reteach and retest pupils until they demonstrated mastery of each objective.

6. A schedule of the instructional periods and the rotation of experimental subject groups during the study. The experimental unit was taught on Monday through Thursday of the first week of the study, which included a school holiday on Friday, and Monday through Wednesday of the second week. To equalize possible effects resulting from the instruc-

tion of one group before the other group, the order of the instructional periods for each group was initially randomized and thereafter reversed daily.

7. The Teaching For Mastery module. Each teacher had her personal copy of the completed training materials returned to her for reference in preparing and teaching the experimental unit.

Training Observers

The eight participating third and fourth grade inservice teachers (in whose classrooms the eight student teachers were working) received a two-hour training session approximately two weeks prior to the beginning of the experimental unit. Most of the session was devoted to instructing the teachers to carry on the comparative observations they would be making each day of the investigation. Each observer was supplied with the items described below for use during the investigation

1. Seven copies of the Comparative Observation Form (Appendix B). The Comparative Observation Form was an observation instrument designed by the primary investigator for daily comparisons of 14 observable teacher or pupil behaviors under the two instructional strategies of the study. Use of the Comparative Observation Forms was explained to all observers, and discussion of each item on the form followed. At the conclusion of the discussions all observers expressed confidence in their ability to use the instrument to record their observations. A description of how the inter-observer reliability was determined is given in the next section of this paper.

2. A schedule of the instructional periods and the rotation of experimental subject groups during the study. The observers were responsible for taking half their pupils with them to the classroom in which they were observing. At the conclusions of the first teaching period each day, the observers escorted the pupils back to their classrooms and

then took the other half of the pupils with them to the classroom in which they were observing. The observers assigned written, non-arithmetic, desk work for their pupils to do while present in a classroom in which instruction for the experimental unit was being conducted. The schedule was arranged such that during the instructional periods all pupils in any one classroom were taught by the same instructional strategy throughout the investigation, i.e., no Group One pupils were present in a classroom where Group Two pupils were being instructed, and no Group Two pupils were present in classrooms where Group One pupils were being instructed.

3. A list of the 14 performance objectives for the experimental unit. Each objective was discussed until all observers expressed an understanding of their meaning.

4. A list of the two groups of pupils they would be escorting to the observation classroom.

5. Sixty copies of the Unit Test. Approximately 30 copies were used for the administration of the pretest for the investigation. The observers administered the pretest to all their pupils on the Thursday preceeding the Monday that marked the beginning of the experimental unit. The remaining copies of the unit test were used for the administration of the posttest for the experimental unit. The observers administered the posttest to all their pupils on the Thursday following the Wednesday on which the experimental unit concluded. The observers allowed no one other than the pupils and the investigator to see the unit test before, during, or after administrations. A description of the procedure used to determine the reliability of the unit test is given in the next section of this paper.

6. Thirty copies of the Pupil Attitude Measure. The observers administered the attitude measure to all their pupils immediately after administering the posttest for the unit. The observers allowed no one other than the pupils and the investigator to see the attitude measure before, during, or after administration. A description of the procedure used to determine the reliability of the attitude measure is given later in this paper.

INSTRUMENT RELIABILITY

Fraction Unit Achievement Test

Posttests from all pupils in one of the fourth grade classes participating in the investigation were used to determine the reliability of the cognitive criterion measure. The instrument was found to have reliability coefficients of 0.83 by the Kuder Richardson (KR-20) method and 0.94 by the Spearman-Brown method.

Pupil Attitude Measure

The Pupil Attitude Measure was administered on two consecutive days following the instructional unit to all pupils (n = 27) in one of the fourth grade classes. The instrument was found to have a reliability coefficient of 0.86 by the test-retest method.

Comparative Observation Form (Appendix B)

To determine the inter-observer reliability on the comparative observation instrument all eight observers observed the same classroom during one of the seven instuctional days of the study. After viewing the classroom events under both instructional strategies, each observer independently completed a Comparative Observation Form.

It was found that all eight observers responded identically to the 14 items on the Comparative Observation Form. The investigators concluded that the observation instrument

was highly reliable and that differences among observers in the present investigation were not reflected in their use of the observation instrument.

ANALYSIS OF DAILY RESPONSES OF OBSERVERS ON THE COMPARATIVE OBSERVATION FORMS

To quantify the differences in classroom behaviors when student teachers followed or did not follow a mastery strategy, values were assigned to the daily responses of observers to each item on the Comparative Observation Forms. Observer, responses that indicated an item description referred to:

a. Behaviors observed only during instruction of Group One subjects (mastery strategy) that day were given a value of +2

b. Behaviors observed mainly during instruction of Group One subjects and to a lesser extent during instruction of Group Two subjects (non-mastery strategy) were given a value of +1.

c. Behaviors observed to the same extent, or not at all, during instruction of both groups were given a value of 0

d. Behaviors observed mainly during instruction of Group Two subjects and to a lesser extent during instruction of Group One subjects were give a value of -1.

e. Behaviors observed only during instruction of Group Two subjects that day were given a value of -2.

For each classroom the values assigned to a descriptive item on the Comparative Observation Forms on Each of five days* of the experimental unit were summed to obtain a score that indicated the relative degree to which differences pertaining to the item description were observed during the instructional unit. A sum value of ±10 indicated maximum observed difference between the experimental groups on an item description. A positive sum indicated that the item description applied mainly to instruction given Group One. A negative sum indicated that the item description applied mainly to instruction given Group Two. Sum values of 0 indicated no cummulative differences observed between the two groups for the item description in question.

The sum values obtained from the compilation of five observation forms for each of the seven classes that completed the experimental unit are show in Table 4.

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*Although the observers used Comparative Observation Forms on each of the seven days of the experimental unit, data from five days of observation were used in this analysis. Not all observers completed the forms on the first day of the unit, and the fourth day of the unit was reserved for the determination of inter-observer reliability as described earlier in this paper.

TABLE 4

Sum Values of Each Item on Five Comparative Observation Forms for Each of Seven Classes

	Class	Observation Form Item Number													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
3rd Grade Classes	A	+2	0	+6	-2	+2	0	0	0	+1	+1	0	0	-3	-1
	B	+10	+8	+10	+5	0	-2	+10	0	-1	+2	0	0	-5	0
	C	+8	+8	+8	+4	0	-2	+7	0	-1	-2	-2	-3	+1	0
4th Grade Classes	D	+10	+2	+10	+10	0	-1	+10	0	0	-1	-2	-3	+5	0
	E	+10	+6	+6	+1	+7	+1	+10	0	+3	+1	0	0	+1	-1
	F	+10	+6	+8	+2	+1	0	+7	0	0	0	0	-3	+3	0
	G	+10	+10	+10	+2	+2	0	+10	0	0	+1	0	0	0	0
Totals		+60	+40	+58	+22	+12	-4	+54	0	+2	+2	-4	-9	+2	-2

The data in Table 4 indicate that the observers reported very sizeable treatment differences between experimental groups pertaining to items 1, 2, 3, and 7 on the Comparative Observation Forms (Appendix B). This indicates that only pupils in Group One (mastery strategy):

a. were frequently tested for mastery of objectives (Item 1);

b. corrected their own tests (Item 2);

c. were considered to have mastered an objective when they achieved the level of competency specified in the objective (Item 3);

d. had their daily progress recorded by their teacher (Item 7).

Less significant treatment differences were also indicated for items 4 and 5. They showed that pupils in Group One (mastery strategy) were given remedial instruction which involved either repetition of the instruction they had already received (Item 4) or some alternate form of instruction (Item 5).

These results verify that the teachers in the present investigation followed the instructional strategies outlined for use with both experimental groups (Appendix A). Another verification of the fidelity of the teachers to the guidelines for the study was the near zero sum value total for item 14, indicating that the protocol for the study was followed to the same extent under each teaching strategy.

An examination of the remaining seven items in Table 4 indicates that virtually no observed differences in teachers' variability (Item 6), teachers' task orientation (Item 8), teachers' giving pupils opportunity to learn (Item 9), teachers' clarity (Item 10), teachers' enthusiasm (Item 11), or teachers' discipline problems (Item 13) were observed in the comparisons of instructional periods for Group One pupils (mastery strategy) and those for Group Two Pupils (non-mastery strategy). The minus nine score for item 12 in Table 4 indicates that Group Two pupils (non-mastery strategy) were observed to be slightly more enthusiastic learners than Group One pupils (mastery strategy).

Experimental Design and Results

A Pretest-Posttest Control Group Design (Campbell and Stanley, 1966) was used to compare the achievement of pupils under both instructional strategies. Pupils in each of four third grade and four fourth grade classrooms were randomly assigned to two groups. Group One pupils in each classroom received instruction for 30 minutes daily for seven consecutive school days from a preservice teacher who used a mastery teaching strategy in an arithmetic unit. Group Two pupils in each classroom received instruction for 30 minutes daily during the same seven consectutive school days from the same teacher who taught their Group One classmates, however the teacher did not use the mastery teaching strategy with Group Two pupils while teaching the arithmetic unit. The two instructional strategies have been operationally defined earlier (Appendix A).

The procedures used in the present investigation were modeled after a procedure described by Worthen (1968). Worthen showed that teachers could vary their teaching behavior sufficiently to effect a test of two differing instructional strategies. The key controlling factors in such experimentation are the clear definition of the differing strategies and the use of observation schemes that verify the adherence of the teachers to the strategies that are being compared. Having each teacher present instruction under both instructional

strategies also allowed the investigation to be conducted with half the number of teachers that would otherwise have been required.

All pupils were given a cognitive criterion measure based on the 14 objectives for the arithmetic unit both four days prior to the beginning of the instructional unit and one day after completion of the instructional unit. A 14 day interval separated the first administration of the cognitive criterion measure, which was the pretest, and the second administration, which was the posttest.

The cognitive criterion measure was scored by assigning four points for correct responses to all test items referring to a single objective and zero, one, two, or three points assigned in cases of less than perfect responses.

The performances of 12* subgroups of pupils on the pretest are summarized in Table 5.

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*To balance the uneven number of replications per cell in the design due to the inability of one of the third grade classes to maintain the experimental schedule, one of the fourth grade classes was randomly eliminated from consideration in the data analysis. The resultant design was a 2 X 2 factorial design with three replications per cell (Dayton, 1970).

TABLE 5

Fraction Unit Pretest Means* and Standard Deviations for Twelve Groups of Pupils**

	Mastery Strategy		Non-mastery Strategy	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.
3rd Grade Classes	11.2	3.0	14.0	3.2
	10.0	4.5	13.5	5.4
	12.5	4.8	14.0	5.1
4th Grade Classes	12.5	5.2	17.0	5.2
	25.5	10.4	27.3	9.1
	17.6	7.5	26.2	13.0

*Maximum obtainable score = 56
**11 pupils per group

A factorial analysis of variance was computed (Dixon, 1970) for the mean pretest scores, and the results of the anaylysis are summarized in Table 6.

TABLE 6

Summary of the Strategies X Grades Analysis of Variance for the Fraction Unit Pretest

Source of Variation	df	MS	F
Strategies (S)	1	42.94	2.24
Grades (G)	1	215.90	11.28*
SxG	1	4.20	< 1.0
Within Cells	8	19.13	

*$p < .01$

The computed value of F for the grade level classification variable exceeds that required for significance. It was concluded that the fourth grade pupils scored significantly higher on the pretest than the third grade pupils as would be expected. To provide a statistical control and adjustment for the differences between the experimental groups prior to treatment the mean scores on the pretest were used as the covariate in an analysis of covariance of the posttest scores.

The performances of the 12 subgroups of pupils on the posttest are summarized in Table 7.

TABLE 7

Fraction Unit Posttest Means* and Standard Deviations for Twelve Groups of Pupils**

	Mastery Strategy		Non-mastery Strategy	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.
3rd Grade Classes	37.1	3.9	34.5	5.7
	34.5	3.9	37.3	5.2
	32.5	5.1	35.5	4.9
4th Grade Classes	33.3	4.6	37.1	7.1
	41.7	8.0	42.8	3.4
	37.5	4.8	43.1	6.1

*Maximum obtainable score = 56
**11 pupils per group

The difference between treatment effects was examined with the following hypothesis:

H_1 There is no significant difference in pupil cognitive achievement which can be attributed to the main effect of the instructional strategy by which the pupils were taught.

The data analyzed in testing this hypothesis are given in Tables 5 and 7, and the results of the computed analysis of covariance (Dixon, 1970) are summarized in Table 8.

TABLE 8

Summary of the Strategies X Grades Analysis of Covariance for the Fraction Unit Posttest

Source of Variation	df	MS	F
Strategies (S)	1	.02	< 1
Grades (G)	1	1.05	< 1
SxG	1	.81	< 1
Within Cells	[illegible]	3.00	

The adjusted group mean scores were calculated (Winer, 1962), and they are compared with the unadjusted group mean scores in Table 9.

TABLE 9

Unadjusted and Adjusted Mean Group Scores for Fraction Unit Posttest

Treatment Factor	Unadjusted Group Mean Scores	Adjusted Group Mean Scores
Mastery Strategy	36.1	37.2*
Non-mastery Strategy	38.4	37.3*
Third Grade	35.2	37.4**
Fourth Grade	39.2	37.0**

*Regression coefficient 0.586
**Regression coefficient 0.518

The computed value of F for the main treatment effect of instructional strategy was less than one, and Hypothesis One was not rejected. The computed values of F for the main effect of the grade level classification and the interaction of strategy and grade level were also less than one and, thus, not significant.

A Posttest-Only Control Group Design (Campbell and Stanley, 1966) was used to compare the attitudes of pupils under both instructional strategies. An attitude measure was administered to all pupils when they had completed the arithmetic unit.

The measure was scored by assigning values to the Likert scale. Responses favoring the instruction pupils received were given a value of five and responses that disfavored the

instruction pupils received were given a value of one. The means and standard deviations of the 12 subgroups of pupils are given in Table 10.

TABLE 10

Fraction Unit Attitude Test Means* and Standard Deviations for Twelve Groups of Pupils**

	Mastery Strategy		Non-mastery Strategy	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.
3rd Grade Classes	32.2	3.0	32.6	2.5
	28.1	3.7	25.1	12.8
	27.1	6.7	29.7	5.8
4th Grade Classes	27.5	7.8	29.5	4.3
	32.1	3.6	31.7	3.9
	32.7	2.3	32.2	1.7

*Maximum positive attitude score = 35
**11 pupils per group

The difference between treatment effects was examined with the following hypothesis:

H_2 There is no significant difference in pupil attitude which can be attributed to the main effect of the instructional strategy by which the pupils were taught.

The data analyzed in testing this hypothesis are given in Table 10, and the results of the computed analysis of variance (Dixon, 1970) are summarized in Table 11.

TABLE 11

Summary of the Strategies X Grades Analysis of Variance for the Fraction Unit Pupil Attitude Test

Source of Variation	df	MS	F
Strategies (S)	1	.10	< 1
Grades (G)	1	9.90	1.25
SxG	1	.10	< 1
Within Cells	8	7.94	

The computed value of F for the main treatment effect of instructional strategy was less than one and Hypothesis Two was not rejected. The computed value of F for the main effect of the grade level classification was less than that required for significance at the 0.05 level. The computed value of F for the interaction of strategy and grade level was also less than one and, therefore, not significant.

DISCUSSION

The hypothesis that studying the Teaching For Mastery module caused preservice elementary school teachers to have more favorable attitudes toward testing and formative evaluation than they had prior to studying the module was supported by the results of this investigation (Table 3). The group of teacher trainees that used the Teaching For Mastery module had significantly higher scores on an attitude measure posttest than the group of teacher trainees that did not use the module. No significant difference in scores on the attitude measure pretest was found between the two groups.

The results support and add to Okey's (1973) finding that a change in the attitudes of teachers toward testing was correlated with their completion of the Teaching For Mastery module. Furthermore, these results have direct and important implications for those individuals involved in training teachers to use mastery learning strategies. Since mastery teaching strategies rely on the use of frequent diagnostic tests, producing favorable attitudes toward testing among teachers receiving such training becomes an important goal. The results of the present investigation support the use of the Teaching For Mastery module to attain that goal.

Preservice teachers who studied the Teaching For

Mastery module were able to use the mastery teaching strategy in conducting instruction in an actual school teaching situation. Although this finding was a necessary prerequisite to the remaining phases of the investigation, it was in itself important to the investigators. Much of the training that teachers receive is given them in anticipation that they will eventually apply the skills they have learned when they are in a classroom teaching situation. Whether or not this occurs is seldom known to the teacher trainer. The availability of training materials, such as Teaching For Mastery, which have been evaluated not only in terms of the skills and attitudes they develop among users, but also in terms of the application of the training in classroom teaching situations, is of great importance to those responsible for training teachers.

The ability of teachers to demonstrate operationally defined instructional strategies, as they did in the present investigation, is also an important methodological concern for those involved in educational research because it provides a means of verifying that the independent variable is operating during the experiment. Process-product studies, such as this investigation, can be an important source of conclusions which can be applied to teacher education programs. In the past, however, such studies have been rare because conducting them presents the researcher with an enormous set of problems because of the necessary

coordination and cooperation of various groups, i.e., teacher trainers, teacher trainees, observers, pupils, school teachers and administrators.

In their review of educational research, Rosenshine and Furst (1971) found only ten studies which satisfied the four criteria for process-product research, i.e., random assignment of teachers or classes to treatment conditions; use of the teacher or class as the statistical unit of analysis; use of observers to collect data on the fidelity of teachers to the behaviors serving as the treatment variables; and use of more than one measure to assess pupil outcomes. The present investigation has demonstrated that the problems of process-product research, though difficult, are not insurmountable. It is the hope of the investigators that this study will be of value in the further development of a model for process-product studies.

The results of this investigation did not support the hypothesis that groups of elementary school pupils taught by teachers who used a mastery teaching strategy would obtain mean scores on a cognitive criterion test that were significantly higher than the same scores of groups of pupils taught by the same teachers not using a mastery teaching strategy (Table 8). However, interpretation of the results should be made with some caution due to the experimental conditions of the present inves-

tigation. That the teachers were able to teach under two differing instructional strategies was verified by the analysis of data obtained from the classroom observers. However, the differences noted by the observers were merely those that were considered essential to the conduct of the experiment, i.e., the teachers used a formative evaluation and remediation process when instructing one group of pupils and did not use this major component of a mastery teaching strategy when instructing a second group.

The similarity of what was observed to occur under the two instructional strategies, rather than the differences, can be used to infer why no significant differences in cognitive achievement were found between the two groups. The five teaching behavior variables identified by Rosenshine and Furst (1971) as having the strongest correlation with pupil achievement were included in the comparative observation scheme used in this investigation. Analysis of the Comparative Observation Forms (Table 4) revealed that, insofar as these five teaching behavior variables (i.e., clarity, variability, task-orientation, enthusiasm, and giving pupils opportunity to learn) were concerned, the teachers exhibited essentially no behavioral differences when using and when not using the mastery teaching strategy.

Perhaps one of the effects the training module had upon the teachers was to make these five teaching behavior variables operative under both teaching strategies, and, therefore, to mask the effects of the mastery teaching

strategy. A replication of the present study in which the non-mastery teaching treatment is administered by teachers who were not trained in mastery teaching strategies would be needed to test this hypothesis.

The lack of a significant difference between the two experimental groups on the cognitive criterion measure may also have been due to the possible use of subtle and unobtrusive diagnostic-prescriptive procedures by the teachers when they were instructing the non-mastery strategy group. Although the observers verified that formal diagnostic testing occured only with the group taught according to the mastery strategy, the teachers may well have been informally assessing the strengths and weaknesses of the non-mastery strategy group, and then prescribing instruction based on those subjective assessments.

The results of this investigation did not support the hypothesis that groups of elementary school pupils taught by teachers who used a mastery teaching strategy would obtain mean scores on an attitude measure that were significantly higher than the same scores of groups of pupils taught by the same teachers not using a mastery teaching strategy (Table 11).

These results do not agree with prior studies on the affective outcomes of mastery teaching strategies (Block, 1973b). However, previous research in this area has been mostly non-experimental and never with the experimental

design used in this investigation. The results might also be expected given the lack of difference in cognitive outcomes and the similarity of teacher behavior variables under both strategies as described in the previous section. Furthermore, the subjective impressions of the investigators were that the well organized structure of the experimental unit had a positive influence upon pupils taught under both instructional strategies. This influence may have masked the effect of the mastery strategy and resulted in the high mean attitude scores of all subgroups of pupils participating in the study. Perhaps a study similar to the present one, should be conducted in which the teachers are not provided with the extensive amount of prepared instructional materials they were given in this study. Such a study might provide a better test of the teacher training effects under more natural classroom teaching circumstances.

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APPENDIX A

PROTOCOL FOR THE EXPERIMENTAL UNIT

TEACHERS' GUIDELINES FOR THE TWO-GROUP STUDY

DIRECTIONS:

Follow the guidelines listed below in teaching this two-week unit on FRACTIONS. your pupils have been randomly assigned to two groups as designated on the attached page. You may tell students from the two groups that their instruction is different but you should not say or imply that you think one form of instruction is better than the other. A summative test for this unit based on the 14 objectives has already been prepared, but you will not see this test until after its administration to both groups at the completion of the unit.

GROUP 1	GROUP 2
Daily instructional time: 30 minutes.	Daily instructional time: 30 minutes.
Do not begin teaching until group 2 pupils have left the classroom.	Do not begin teaching until group 1 pupils have left the classroom.
Teach the 14 objectives in the order they are listed.	Teach the 14 objectives in the order they are listed.
Have pupils use Chapter 10 in Elementary School Mathematics: Book 3. Use pages in this text in any sequence you judge appropriate for the objectives being pursued.	Have pupils use Chapter 10 in Elementary School Mathematics: Book 3. Use pages in this text in any sequence you judge appropriate for the objectives being pursued.
Do not assign homework from the textbooks that requires students' use of the books outside of the daily 30 minute classes.	Do not assign homework from the textbooks that requires students' use of the books outside of the daily 30 minute classes.
Use the Teachers' Edition of the text, any suggestions it offers and supplementary materials it provides as you see fit. However, do not use any other supplementary instructional materials.	Use the Teachers' Edition of the text, any suggestions it offers and supplementary materials it provides as you see fit. However, do not use any other supplementary instructional materials.
Cooperate with the observing teacher by answering questions she may pose to you or by showing her any lesson plans, instructional materials, or record keeping devices you are using for this unit.	Cooperate with the observing teacher by answering questions she may pose to you or by showing her any lesson plans, instructional materials, or record keeping devices you are using for this unit.
Use the FIVE STEP PLAN FOR MASTERY TEACHING for which you were trained in the Teaching For Mastery program. Steps 1 & 2 (Developing objectives for the unit, & Developing evaluation measures for the objectives) have already been done for you. You are to carry out steps 3, 4, & 5 (Teaching, Identifying learning difficulties through formative evaluation procedures, & Reteaching and retesting as needed).	Do not use the FIVE STEP PLAN FOR MASTERY TEACHING for which you were trained in the Teaching For Mastery program. However do use the objectives in the order they are listed to plan your instruction.
Use the formative tests provided to you for frequent determination of each pupil's progress.	Do not use any formative tests. Do not give any tests or quizes in this unit.
Use as many new skills you can that you acquired specifically through the Teaching For Mastery program.	Do not use those new skills that you acquired specifically through the Teaching For Mastery program.

APPENDIX B

COMPARATIVE OBSERVATION FORM

Date: _____

Observer: _____

Teacher: _____

OBSERVER'S DIRECTIONS:

Complete one of these observation forms each day during the last five minutes of Period B; then give the form to Mr. Ciesla.

On the left side of this form are descriptions of events you may have observed during the teacher's first teaching period, (Period A), or during her second teaching period, (Period B). For each description you are to circle one of the six designations on the right side of the form to indicate what you observed.

Circle A-------If the description applies only to Period A.
Circle Ab------If the description applies mainly to Period A and to a lesser extent to Period B.
Circle ab------If the description applies equally to Periods A & B.
Circle aB------If the description applies mainly to Period B and to a lesser extent to Period A.
Circle B ------If the description applies only to Period B.
Circle N ------If the description applies to neither Period A nor Period B.

1. After pupils completed instruction covering one or more objectives, they were tested for mastery of these objectives.	1. A	Ab	ab	aB	B	N
2. Pupils corrected their own tests.	2. A	Ab	ab	aB	B	N
3. Pupils' performances on tests were judged acceptable when they achieved the level of competency specified in the performance objectives.	3. A	Ab	ab	aB	B	N
4. When pupils failed to demonstrate mastery of an objective they were directed to repeat the same instruction they had received.	4. A	Ab	ab	aB	B	N
5. When pupils failed to demonstrate mastery of an objective they were given some alternate form of instruction.	5. A	Ab	ab	aB	B	N
6. The teacher used a variety of instructional methods in teaching.	6. A	Ab	ab	aB	B	N
7. The teacher kept a record of each pupil's daily progress.	7. A	Ab	ab	aB	B	N
8. The teacher conducted a lesson aimed at one or more of the objectives on the attached pages.	8. A	Ab	ab	aB	B	N
9. Pupils were given ample opportunity to learn.	9. A	Ab	ab	aB	B	N
10. Pupils clearly understood what the teacher expected them to do.	10. A	Ab	ab	aB	B	N
11. The teacher was enthusiastic in her teaching.	11. A	Ab	ab	aB	B	N
12. The pupils were enthusiastic learners.	12. A	Ab	ab	aB	B	N
13. Discipline was a problem for the teacher.	13. A	Ab	ab	aB	B	N
14. The teacher observed the guidelines as set forth on the attached page.	14. A	Ab	ab	aB	B	N