DOCUMENT RESUME

ED 108 957 95 SE 019 383

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TITLE Logial Task Performance in the Preschool: The Effects of Classification and Seriation Instruction. Technical Report No. 270.
INSTITUTION Wisconsin Univ., Madison. Research and Development Center for Cognitive Learning.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C. Career Education Program.
PUB DATE Sep 73
CONTRACT NE-C-00-3-0065
NOTE 26p.

EDRS PRICE MF-$0.76 HC-$1.95 PLUS POSTAGE
DESCRIPTORS Cognitive Development; Conservation (Concept); Developmental Tasks; Educational Research; Instruction; *Learning; *Preschool Education; *Science Education; *Serial Learning; *Transfer of Training
IDENTIFIERS Piaget (Jean); Research Reports

ABSTRACT

The efficacy of small group instructional programs in classificatory, seriation, and combined class/series skills was evaluated for a sample of 60 urban, middle-class, 4- to 5-year-old children in a transfer of training design. Significant curriculum-specific transfer effects were found for the seriation instructional condition, whereas little differences were found for the classification, verbal intelligence, and far-transfer conservation task measures. Sex differences, school location effects, teacher biases, and pretesting effects were generally absent. The apparent feasibility of seriation skill instruction for preschool-aged children and the general noneffectiveness of the classificatory and combined instructional conditions, particularly insofar as far-transfer effects are concerned, suggest a nonunitary picture of cognitive functioning during the transitory phases between preoperational and concrete operational period thought. (Author)

LOGICAL TASK PERFORMANCES IN THE PRESCHOOL: THE EFFECTS OF CLASSIFICATION AND SERIATION INSTRUCTION

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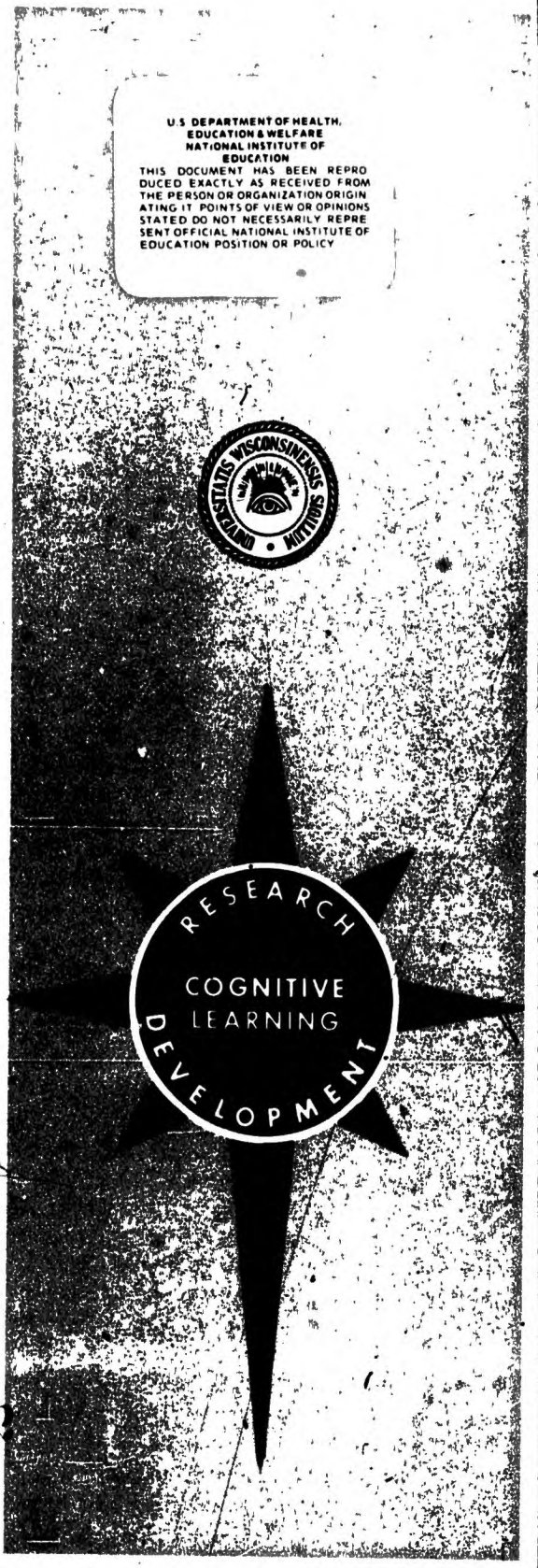

Technical Report No. 270

LOGICAL TASK PERFORMANCES IN THE PRESCHOOL: THE EFFECTS OF CLASSIFICATION AND SERIATION INSTRUCTION

by

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Report from the Project on Conditions of
School Learning and Instructional Strategies

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September 1973

Published by the Wisconsin Research and Development Center for Cognitive Learning, supported in part as a research and development center by funds from the National Institute of Education, Department of Health, Education, and Welfare. The opinions expressed herein do not necessarily reflect the position or policy of the National Institute of Education and no official endorsement by that agency should be inferred.

Center Contract No. NE-C-00-3-0065

Statement of Focus

Individually Guided Education (IGE) is a new comprehensive system of elementary education. The following components of the IGE system are in varying stages of development and implementation: a new organization for instruction and related administrative arrangements; a model of instructional programing for the individual student; and curriculum components in prereading, reading, mathematics, motivation, and environmental education. The development of other curriculum components, of a system for managing instruction by computer, and of instructional strategies is needed to complete the system. Continuing programmatic research is required to provide a sound knowledge base for the components under development and for improved second generation components. Finally, systematic implementation is essential so that the products will function properly in the IGE schools.

The Center plans and carries out the research, development, and implementation components of its IGE program in this sequence: (1) identify the needs and delimit the component problem area; (2) assess the possible constraints—financial resources and availability of staff; (3) formulate general plans and specific procedures for solving the problems; (4) secure and allocate human and material resources to carry out the plans; (5) provide for effective communication among personnel and efficient management of activities and resources; and (6) evaluate the effectiveness of each activity and its contribution to the total program and correct any difficulties through feedback mechanisms and appropriate management techniques.

A self-renewing system of elementary education is projected in each participating elementary school, i.e., one which is less dependent on external sources for direction and is more responsive to the needs of the children attending each particular school. In the IGE schools, Center-developed and other curriculum products compatible with the Center's instructional programing model will lead to higher student achievement and self-direction in learning and in conduct and also to higher morale and job satisfaction among educational personnel. Each developmental product makes its unique contribution to IGE as it is implemented in the schools. The various research components add to the knowledge of Center practitioners, developers, and theorists.

Acknowledgments

The authors wish to acknowledge the assistance of Mary Ann Schauer in carrying out the present study. The courtesy extended us by Judy Williston, Lois Klessig, and Harriet Cuthbert in allowing us to include the children in their classrooms in this study is also appreciated. An abridged version of this research was presented at the biennial meeting of the Society for Research in Child Development, Philadelphia, March 1973.

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Abstract

The efficacy of small group instructional programs in classificatory, seriation, and combined class/series skills was evaluated for a sample of 80 urban, middle-class, 4- to 5-year-old children in a transfer of training design. Significant curriculum specific transfer effects were found for the seriation instructional condition, whereas little differences were found for the classification, verbal intelligence, and far transfer conservation task measures. Sex differences, school location effects, teacher biases, and pretesting effects were generally absent. The apparent feasibility of seriation skill instruction for preschool-aged children and the general non-effectiveness of the classificatory and combined instructional conditions, particularly insofar as far transfer effects are concerned, suggests a nonunitary picture of cognitive functioning during the transitionary phases between preoperational and concrete operational period thought.

I
Introduction

The general application of Piagetian theory to the design of educational programs for the preschool-aged child, and the specific relevance of relatively structured experience to the acquisition of Piagetian concepts, are currently being studied by many investigators. Within the context of the ever growing Piagetian training literature (Beilin, 1971; Brainerd & Allen, 1971; Hooper, Goldman, Storck, & Burke, 1971; Klausmeier & Hooper, in press), the present study was another attempt to explicate the potential role of instructional experiences as determinants of Piagetian concept task performances. The efficacy of small group instructional programs in classificatory, seriation, and combined classificatory/seriation skills was evaluated for a sample of urban, middle-class, 4- to 5-year-old children in a transfer of training design.

Recent investigators have examined the interdependencies among the putatively related concrete operational concept domains dealing with classes, relations, and conservation. The interdependencies among these concept domains follow directly from the within-stage correspondence assumptions of Piagetian theory (Flavell, 1970, 1971; Wohlwill, 1963), which predicts correlation and associated developmental synchrony. Sigel, Roeper, and Hooper (1966) gave gifted preschool children (Stanford-Binet I.Q. scores 140-150) structured small group experiences in multiple labeling of stimulus attributes and multiplicative classification and relationality, followed by a concluding session on aspects of reversibility. Significant nonspecific transfer effects were found for quantity and weight conservation tasks. Sigel and Shantz (cited in Shantz & Sigel, 1967) compared the performance of subjects given multiple labeling and classification instruction to that of a control group (average age 4 years, 10 months) on quantity, weight, and area conservation tasks. They found significant gains on quantity and weight conservation. Shantz and Sigel (1967) evaluated the effects of multiple-labeling classification and discrimination-memory instructional experiences. Thirty-six nonconserving kindergarten children who passed a pretest on relational term comprehension (Griffiths, Shantz, & Sigel, 1967) were randomly assigned to a training condition (four labeling-classification and two discrimination-memory groups, with 6 children and a teacher in each group). Posttesting revealed very little difference between the two instructional conditions (a control condition was not included) with regard to performance on classification, seriation, reversibility, or conservation tasks.

Using a posttest-only design, Hooper (1972) evaluated separate task-sequence based, classificatory and relationality (seriation) training conditions for samples of 3 1/2- to 4 1/2-year-old children in small group instructional settings. Classificatory instruction was not effective, but seriation instruction resulted in significant specific transfer—most notably in the older children. No far transfer to conservation tasks was indicated for either training condition. However, similar task analysis approaches, albeit in a more highly structured, individual instruction format, have been shown to be effective in enhancing the dual classification skills of children (e.g., Caruso & Resnick, 1972; Jacobs & Vandeventer, 1971a, 1971b; Parker, Rieff, & Sperr, 1971; Parker, Sperr, & Rieff, 1972).

The present study may be viewed as a replication and extension of the Hooper (1972) training investigation (see also Franz, Kincaid, & Hooper, 1971, and Kincaid, Franz, & Hooper, 1971). Small, group-based classificatory and seriation instructional conditions were included in addition to a new, combined class/series instructional sequence. It was anticipated that each instructional condition

would produce significant specific transfer to the classificatory and seriation criterion performance measures. In view of the theoretical statements of Pinard and Laurendeau (1969, pp. 158-159) that "... it would perhaps be even more promising to train the child on more than one grouping at a time (e.g., a classification and a seriation)" and the specific predictions of Hooper (1973), the combined class/series instructional condition was expected to result in superior far transfer to conservation task settings.

II
Method

Subjects

Sixty middle-class, urban children aged 3 years, 4 months, to 5 years, 9 months attending two preschool programs in Madison, Wisconsin, were randomly assigned to one of 15 experimental conditions. The overall sample consisted of 32 males and 28 females. The general characteristics (age, intelligence, and task scores on relational terms) of the various experimental groups are presented in Table 1.

Design

Because the self-instructional effect of repeated Piagetian task administrations is recognized (Beilin & Franklin, 1962; Smedslund, 1961; Sigel, 1968), a variation of the relatively demanding, Solomon four-group design (Campbell & Stanley, 1963) was used. This permitted the evaluation of potential pretesting or pretest/treatment interaction effects. As indicated in Table 1, two training groups for each treatment condition (one pretested and one nonpretested group) were arranged for each preschool location. In addition, one control group was assigned to preschool A and two control groups to preschool B. Children were approximately matched for age across groups.

Twelve children from the Preschool A morning group were randomly assigned, four per group, to the three major training conditions. Sixteen children from the Preschool A afternoon group were randomly assigned, four per group, to three training conditions and one control group. Each of the classrooms in Preschool A was already a mixed-age group. The classrooms in Preschool B were grouped by age. To mix ages and yet not isolate any child from familiar peers, pairs of children from each class were randomly assigned to groups. The resulting groups of four were then randomly assigned, two groups each, to the three training conditions and the control groups.

Instructional Conditions

For each of ten training sessions, a group of four children met with a trained teacher for 20 to 30 minutes in a room separate from the regular classroom. Repetition was built into each of the training sessions to enhance learning and compensate for any absences. Children who missed more than one session were individually given a make-up session as soon as possible after the absence. Each training group was taught entirely by the same teacher. The overall instructional programming was equally shared by two preschool teachers. In this way, any potential teacher bias could later be evaluated.

The three control groups were taken from the nursery classrooms for the same amount of time as the experimental groups. The materials used with the experimental groups were invitingly displayed for the control children to use. However, there was no teacher direction, reinforcement, or interaction. The ten training sessions were conducted in a game-like atmosphere. Verbal reinforcement was used extensively by the teachers, and reinforcement, interaction, and correction by the children was encouraged.

Seriation training sessions

The seriation sessions basically follow those developed in The Ypsilanti Early Education Program and *The Preschool Curriculum Development Project* (Hooper & Marshall, 1968). Minor changes were made from the format of those lessons previously used by

TABLE 1

General Characteristics of the Various Subject Subsamples
(Standard Deviations Presented in Parentheses)

		Age Ranges (Months)	Mean Ages	*PPVT* (Form A) Means	I.Q. Pretest	*PPVT* (Form B) Means	I.Q. Posttest	Rel. Terms Means	Pretest	Rel. Terms Means	Posttest
Preschool A											
Seriation	P*	50–59	55.25	117.00	(5.35)	116.00	(16.71)	7.00	(2.65)	8.00	(2.00)
Seriation	NP	55–67	62.00			126.25	(12.15)			7.00	(3.37)
Classification	P	49–63	57.00	117.00	(5.45)	115.50	(9.15)	7.25	(1.71)	9.00	(0.00)
Classification	NP	57–64	60.75			113.75	(7.04)			7.50	(1.29)
Combination	P	49–62	54.75	112.75	(10.23)	103.50	(19.07)	6.00	(2.94)	8.50	(.58)
Combination	NP	50–61	54.00			124.50	(6.14)			8.50	(1.00)
Control	NP	48–65	55.00			113.25	(7.04)			8.75	(.50)
Preschool B											
Seriation	P	59–66	59.75	114.00	(6.32)	113.50	(6.14)	8.25	(6.90)	9.00	(0.00)
Seriation	NP	47–56	51.50			109.00	(5.35)			7.25	(1.71)
Classification	P	44–56	49.00	120.75	(4.57)	118.50	(4.76)	7.75	(2.20)	8.75	(.50)
Classification	NP	54–65	60.50			98.50	(9.15)			8.50	(1.00)
Combination	P	56–66	59.75	129.33	(19.23)	114.33	(10.26)	9.00	(0.00)	9.00	(0.00)
Combination	NP	46–69	54.00			105.50	(15.00)			7.25	(1.71)
Control	P	45–62	44.00	117.25	(9.11)	106.00	(4.24)	7.50	(1.29)	8.00	(1.41)
Control	NP	40–63	52.50			111.25	(4.19)			7.50	(9.00)

*P = pretested; NP = not pretested.

Hooper (1972). Two sessions which were repetitive in terms of activities and related materials were omitted.

Seriation training develops the ability to arrange in a sequence a set of objects which differ in some quality. The ten training sessions, each lasting 20-30 minutes and extending over a three-week period, followed this developmental sequence:

1. Comparison between two sizes—the ability to identify the largest and smallest of pairs of objects.
2. Relative comparison—the ability to identify the same object as now large, now small, depending upon the size of simultaneously presented comparison figures.
3. Successive comparison—the ability to apply relative comparisons in systematic fashion to each of a number of simultaneously presented objects.
4. Serial correspondence—the ability to construct a one-to-one correspondence between two sequences of objects in which the elements of the sequences correspond because they have the same relative position in the sequence.
5. Additive seriation—the ability to arrange objects in a sequence and then insert appropriately several more objects into the original sequence.
6. Multiple seriation—the ability to arrange in a sequence a set of objects which differ in more than one attribute.

An example of a representative seriation training session appears below:

Session VIII Materials: 6 barrels; 5 paper glasses of juice; 7 houses; 7 dogs; and 10 green cylinders.

1. Introduce 6 barrels. Discuss what they are. Ask *Ss*, "What can we do with these?"
   a. Have a *S* operate nesting task. Have others correct.
   b. Pose question—"What else can we do with these barrels?" Have another *S* place barrels in order.
   c. After task is completed, ask a *S* to point to the largest one, another *S* point to the smallest one. Verbally reinforce—"Yes, this is the largest." Etc.
2. Introduce 5 glasses of juice in random order. "What kind of juice could be in these glasses?"
   a. Comment on juice time at school. Suggest to *Ss* that they should be placed just right on the table, for each glass has its very own place. Have a subject complete task.
   b. Play teacher makes a mistake game—place them in a disorderly arrangement. Ask a *S* if this is the right way. Why? Have that *S* arrange them in order.
   c. Repeat procedure until each *S* has a turn.
3. Introduce 7 houses and 7 dogs. Explain that these little dogs are lost. Each dog has his very own house.
   a. Ask a *S* if he knows a way to help the dog find his very own home. If no response, repeat sequential steps for the *Ss* to see how the dogs find their homes.
   b. After dogs are in their homes, tell *Ss* that how the dogs would like to go out to play. Have a *S* help them find their homes again.
   c. Repeat sequence with different stories until each *S* has a turn.
4. Introduce 10 cylinders.
   a. "Remember how we made a stairway for our animals to climb?" Have *Ss* take turns performing the task. If possible have them verbalize the operation they use, beginning with the smallest or largest.
   b. Have *Ss* cover their eyes. Remove a cylinder. Let each *S* have a turn in replacing a cylinder into the stairway.

Classification training sessions

Classification training develops the ability to group things according to an attribute or attributes. This training consisted of ten 20-30 minute sessions over a period of three weeks. The developmental sequence used was as follows:

1. Resemblance sorting—ability to select from two objects one which re-

sembles part of a previously arranged pattern of objects. The one to be selected resembles a part of the pattern, but is not like it in shape or color.

2. Consistent sorting—ability to select objects from a mixed array which are alike in some perceptual feature.
3. Exhaustive sorting—ability to group every object possessing a given attribute or a combination of attributes.
4. Some and all—the ability to compare the extensions of intersecting classes. If one class is included in another, then all the smaller class is only part (some) of the larger. Conversely, some (a part) of the larger class is the same as all of the smaller.
5. Dual class membership—ability to recognize that an object can belong to more than one class at once because the object shares qualities in common with more than one class.
6. Whole is the sum of its parts—the ability to recognize that if B is a large class divisible into two mutually exclusive parts, A and A', the number of objects in A and A' is equal to the number of objects in the superordinate class B, A + A' = B.

This sequence of sessions is based on Kofsky's (1966) scalogram study of the development of classification skills. The sessions progress in complexity to the tenth session.

An example of a representative classification training session appears below:

Session IX Materials: Family of 4; dishes (4 cups, plates, forks, spoons); toothbrushes (2 different sizes and colors); 2 boxes.

A. Introduce family of four. Multiple labeling. "What can you tell me about this family?" There are 4 people, they eat, sleep, run, play, etc.

B. Introduce set of dishes—multiple labeling.

C. Present family and other mixed materials. Ask a *S* to put the things together that go together.

D. With a toothbrush and a boy—pose question. "Can this toothbrush and this boy belong together in some way?" Why?

E. Introduce a small green toothbrush.
   1. Multiple labeling—probe and suggest.
   2. Present large yellow toothbrush. Find similarities and differences.

F. Place all brushes on table and have a *S* put those brushes together that are just alike. Have *Ss* check correctness of groupings.

G. Place two boxes on the table and have *S* find a way of putting the things together that go together another way.

H. With the same two boxes, ask a *S* to find another way of putting the brushes together.

I. Place a mother and large blue toothbrush in center of table. Ask *Ss* if they belong together in some way.

Combined classification/seriation training sessions

The combined training consisted of ten 20-30 minute sessions spaced over a period of three weeks. Each session combined a portion of materials and exercises from one seriation training session and one classification training session. The sessions followed the same developmental sequences as the separate sessions. Repetition of exercises and materials was further eliminated, making it possible to combine the separate instructional units into ten sessions.

An example of a representative combined class/series training session appears below:

Session VIII Materials: 5 paper glasses of juice; 7 houses; 7 dogs; and 10 cylinders.

1. Introduce 5 glasses of juice in random order. "What kind of juice could be in these glasses?"
   a. Comment on juice time at school. Suggest to *Ss* that they should be placed just right on the table, for each glass has its very own place. Have a subject complete task.
   b. Play teacher makes a mistake game—place them in a disorderly arrangement. Ask a *S* if this is the right way. Why? Have that *S* arrange them in order.
   c. Repeat procedure until each *S* has a turn.

2. Introduce 7 houses and 7 dogs. Explain that these little dogs are lost. Each dog has his very own house.

   a. Ask a *S* if he knows a way to help the dogs find their very own homes. If no response, repeat sequential steps for the *S*s to see how the dogs find their homes.
   b. After dogs are in their homes, tell *S*s that now the dogs would like to go out to play. Have a *S* help them find their homes again.
   c. Repeat sequence with different stories until each *S* has a turn.

3. Introduce 10 cylinders.

   a. "Now we will make a stairway for our animals to climb." Have *S*s take turns performing the task. If possible have them verbalize the operation they use, beginning with the smallest or largest.
   b. Have *S*s cover their eyes. Remove a cylinder. Let each *S* have a turn in replacing a cylinder into the stairway.

Materials: Family of 4; dishes (4 cups, plates, forks, spoons).

A. Introduce family of four. Multiple labeling. "What can you tell me about this family?" There are 4 people, they eat, sleep, run, play, etc.

B. Introduce set of dishes—multiple labeling.

C. Mix up family and other materials. If you were the mother how would you clean up these messy things so that the things which belong together are together? Ask a *S* to put the things together that go together.

D. Place a mother and a fork in the center of the table. Ask *S*s if they belong together in some way.

Assessment Measures

1. The *Peabody Picture Vocabulary Test* (form B) was administered to all subjects as a posttest measure. Subjects who were pretested received the *P.P.V.T.* form A.

2. Piagetian assessment tasks:

   a. Relational terms task—a measure of comprehension of the criterial terms used in the conventional conservation task (Griffiths, Shantz, & Sigel, 1967) was administered. It consisted of three trials dealing with (1) "more," (2) "same," and (3) "less" for the content domains of continuous quantity (water), number (colored pencils), and area (Lego blocks), respectively. The possible score range on this measure was 0-9.
   b. Seriation measures—the seriation test series followed the same hierarchial sequence described in the seriation instructional program although different stimulus materials were used. The seriation test series included (in the following presentation order) four tasks using different sized blocks adapted from Elkind (1964); absolute comparison (score range 0-2), relative comparison (0-3), successive comparison (0-7), and additive seriation (0-3); a serial correspondence task using an ordered series of sticks and circles adapted from Coxford (1964), score range 0-11; and a pictorial measure of multiplicative seriation understanding (Shantz & Sigel, 1967), score range 0-3. The overall possible score range for the seriation test series was 0-29.
   c. Classification measures—the classificatory test series, while utilizing different stimulus materials, also followed the developmental sequence embodied in the classification instructional program. The classification task array included (in the following order of presentation) six tasks using three dimensional blocks whose attributes varied in color, size, and shape, adopted from Kofsky (1966); resemblance sorting (score range 0-2), consistent sorting (0-1), exhaustive sorting (0-3), "some" and "all" relationships (0-4), multiple class membership (0-4), and class addition, i.e., B = A + A' (0-2); and a pictorial measure of multiplicative classificatory understanding (Shantz & Sigel, 1967), score range 0-3. The overall possible score range for the classificatory test series was 0-19.
   d. Conservation measures—the conservation task arrays included:
      1. Number conservation using

colored poker chips (Rothenberg, 1969) which consisted of lateral displacement, compression of one row, resubgrouping, equal addition to both rows, and a "trial-check" of unequal addition (score range 0-5);

2. Quantity conservation using modeling clay which consisted of three deformations (cup, pancake, and hot dog shapes) and a final "trial-check" in which clay was removed from one of the stimuli (score range 0-4); and
3. Conservation of surface area using green cardboard "fields," toy cows, and various configurations of barns (Piaget, Inhelder, & Szeminska, 1960) which consisted of three trials (3, 9, and 6 barns, respectively) and a final "trial-check" in which a barn was removed from one of the fields (score range 0-4).

In order to pass any of the conservation trials the subject had to select the correct objective response and also supply an adequate explanation or rationale, e.g., statements involving addition-subtraction schemes, reversibility, proportionality or compensatory relations, reference to the previous state of equality, etc. A subject was classed as a conserver if he passed three to four trials for the number case and three trials for the quantity and surface area cases in addition to correctly answering the "trial-check" for each content domain.

3. General procedures.
The overall assessment battery was individually administered in two sessions. The pretesting sessions took place 3-4 weeks prior to the onset of the instructional program and the posttesting sessions were completed during the 3 weeks following the completion of the training experiences. The tests were administered by seven test administrators who were randomly assigned to children from all instructional and control conditions and were held in a room separate from the children's classroom. The test administrators were unaware of the children's participation in the various treatment/control conditions. The subjects who received pretest and posttest administrations had the same administrator for both sessions and the material was presented in the same order. All the test sessions were tape recorded to facilitate the accurate scoring of the children's objective responses and associated explanations. All subjects received the tasks in one of the following randomly assigned presentation orders:

1. Relational terms (number, quantity, and area), seriation task series, classification task series, conservation tasks (number, quantity, and area), and *P.P.V.T.*;
2. Relational terms, conservation tasks, *P.P.V.T.*, seriation task series, and classification task series.

All of the various tasks were presented in a relaxed, game-like atmosphere and no explicit reinforcement regarding correct responses was provided.

III
Results

Preliminary analyses dealt with a number of related issues including pretest differences, testing effects, preschool location and teacher biases, sex differences, and order of presentation effects. For the seven pretested groups, variance analyses for the *P.F.V.T.* I.Q. scores and relational terms understanding scores (see Table 1) indicated a lack of significant differences.

The effects of pretesting in the present study were minimal. Table 2 presents the seriation and classification total score means and standard deviations. Because subjects were lost from two of the pretested groups (see Table 2), a comprehensive analysis of pretest and pretest/treatment interaction effects was precluded. Means comparisons, as suggested by Campbell and Stanley (1963), revealed a notable lack of pretesting influences except for the classification total scores comparison in which the pretest-treatment-posttest condition was significantly superior to

TABLE 2

Total Score Means and Standard Deviations
on Seriation and Classification Measures for the Various Conditions
(N = 4 for each condition unless indicated)

Experimental Groups		Seriation				Classification			
		Pretest		Posttest		Pretest		Posttest	
		Means	S.D.	Means	S.D.	Means	S.D.	Means	S.D.
Seriation Instruction	1. a	23.00	3.61	26.00	.82	13.00	0.00	12.00	1.53
	2. a			22.25	1.89			10.75	2.63
	3. b			25.00	1.41			11.25	3.69
	4. b	18.75	5.12	25.75	2.63	11.25	1.50	14.25	3.59
Classification Instruction	1. a	19.50	4.36	22.00	4.69	12.00	1.66	14.25	1.50
	2. a			20.25	4.03			10.00	2.16
	3. b			19.50	3.11			11.25	1.89
	4. b	13.25	4.57	20.00	4.55	10.00	.81	11.75	1.26
Combined Instruction	1. a			22.75	4.19			11.25	1.26
	2. a	18.50	5.20	17.00	7.62	8.75	2.99	9.50	2.08
	3. b			20.25	3.40			9.25	2.63
	4. b*	19.25	4.99	22.33	8.33	12.25	2.06	12.67	2.52
Control	1. a			18.75	1.50			10.25	2.87
	2. b			19.25	5.62			11.25	3.78
	3. b**	17.50	4.80	23.50	4.95	10.50	1.29	13.00	1.41

a = Preschool A
b = Preschool B

* N = 3
** N = 2

the nonpretested treatment conditions, $t(45) = 2.52$, $p < .02$. No differences were observed with regard to the conservation tasks.

Comparisons of the respective seriation and classification total score patterns (t tests) and frequency of conserving subjects (χ^2 comparisons) for the two preschool locations, the two instructors, and the male versus the female subjects subsamples were uniformly nonsignificant. There were no differences favoring either order of presentation for the relational terms, seriation, classification, or conservation tasks.

A number of between group variance heterogeneity comparisons (F max tests) were conducted and several significant departures from homogeneity were found. However, recent views concerning the robustness of parametric analyses of variance (cf. Winer, 1962) indicates that the overall result patterns are not influenced by these variance homogeneity distinctions.

The primary analyses concerned the posttest score patterns of four main subsamples: all the children trained on seriation (N = 16); on classification (N = 16); on the combined class/series program (N = 15); and the contact control group (N = 10). Separate analyses of variance compared the total seriation score and total classification score and the *P.P.V.T.* I.Q. scores for these four groups. Only the seriation total score ANOVA was significant, $F(3, 53) = 4.32$, $p < .01$. Individual comparisons indicated that the mean for the seriation instructed group (24.75) was superior to the classification group (20.44), the combined instructional conditions group (20.47), and to the control group (19.90).

The subtask mean score patterns for the seriation and classification test series are presented in Tables 3 and 4, respectively. Variance analyses indicated significant differences among the groups' scores for the following seriation subtasks: relative comparison, $F(3, 53) = 5.02$, $p < .01$, successive comparisons, $F(3, 53) = 9.42$, $p < .01$, and multiplicative seriation, $F(3, 53) = 6.26$, $p < .01$. In the relative comparisons subtask case, individual post hoc comparisons indicated that the seriation, $t(24) = 2.63$, $p < .01$, and the classification instructional conditions, $t(24) = 2.22$, $p < .05$, were significantly superior to the control subjects. In the successive comparisons subtask case, the scores of the classification instructional condition subjects were found to be significantly inferior to their seriation, combined, and control condition counterparts. The multiplicative seriation scores (subtask VI) of the seriation instructional condition subjects were significantly superior to those of the subjects in the classification, $t(30) = 4.44$, $p < .01$ and control conditions, $t(24) = 3.74$, $p < .01$, but did not differ from the combined instructional condition (see Table 3). No significant differences among the various classificatory subtask scores were found.

The percentage of subjects passing the posttest conservation tasks for the various experimental subsamples are presented in Table 5. Although there is some indication of superiority for the seriation instruction condition, especially for the most difficult conservation task, all the χ^2 comparisons were nonsignificant.

Considering the pretest/posttest score changes for the appropriate subsamples, the following significant differences were observed: (1) the seriation trained group's total seriation mean score increased from 20.57 to 25.86, $t(6) = 2.50$, $p < .05$; (2) the classification trained group's total classification mean scores increased from 11.00 to 13.00, $t(7) = 6.06$, $p < .01$; (3) the classification trained group's total seriation mean scores increased from 16.38 to 21.00, $t(7) = 4.97$, $p < .01$; and (4) the combined training group's mean *P.P.V.T.* I.Q. score decreased from 119.86 to 108.14, $t(6) = 2.76$, $p < .05$. While the small number of subjects who conserved on posttesting precluded a direct analysis, some improvement was shown in all the experimental groups and this was most notable for the children receiving seriation instruction, i.e., the number of conservation tasks passed on pretesting compared to posttesting was 3/9, 0/4, 2/5, and 2/3 for the seriation, classification, combined, and control conditions, respectively. Only one subject (N = 27) failed a posttest conservation task which had been passed during the pretesting phase.

The relationship of the various Piagetian task performances to chronological age was examined by dividing the overall sample by a median split into high and low age groups. Comparisons of means indicated superiority for the older subjects on total seriation scores (22.93 vs. 20.25) t (55) = 2.293, $p < .05$, and total classification scores (12.45 vs. 10.57) t (55) = 2.78, $p < .01$. The Pearson correlation coefficients for these two cases were +.34 and +.37, $p < .02$, respectively. 2 x 2 (pass/fail and high/low age) χ^2 comparisons and related Phi coefficients were as follows: number conservation, $\chi^2 = 2.70$, $\phi = .24$, quantity conservation, $\chi^2 = 2.83$, $\phi = .27$, and surface area conservation, $\chi^2 = 5.65$, $\phi = .36$.

The interrelationship of the present Piagetian task performances was examined by comparing the total seriation and classification mean scores of conserving and nonconserving subjects. In each instance the con-

TABLE 3

Mean Seriation Posttest Scores and Standard Deviations for Each Training Condition
(Standard Deviations Presented in Parentheses)

Seriation Subtasks and Score Ranges		Experimental Group: Seriation (N = 16)	Classification (N = 16)	Combined (N = 15)	Control (N = 10)
I. Absolute Comparisons	[0-2]	2.00 (0)	2.00 (0)	2.00 (0)	1.90 (.3)
II. Relative Comparisons	[0-3]	2.44 (.60)	2.25 (.44)	1.53 (1.03)	1.90 (.3)
III. Successive Comparisons	[0-7]	6.88 (.45)	5.25 (1.71)	6.20 (1.22)	6.10 (1.22)
IV. Additive Seriation	[0-3]	2.93 (.33)	2.12 (.88)	2.33 (1.08)	2.20 (1.23)
V. Serial Correspondence	[0-11]	9.18 (1.59)	8.81 (1.57)	7.47 (3.0)	7.50 (2.62)
VI. Multiplicative Seriation	[0-3]	1.31 (.69)	.31 (.59)	.87 (.88)	.30 (.64)

TABLE 4

Mean Classification Posttest Scores and Standard Deviations for Each Training Condition
(Standard Deviations Presented in Parentheses)

Classification Subtasks and Score Ranges		Experimental Group: Seriation (N = 16)	Classification (N = 16)	Combined (N = 15)	Control (N = 10)
I. Resemblance Sorting	[0-2]	1.69 (.45)	1.69 (.57)	1.27 (.68)	1.90 (.3)
II. Consistent Sorting	[0-1]	.94 (.24)	.94 (.24)	.93 (.26)	1.00 (0)
III. Exhaustive Sorting	[0-3]	3.00 (0)	3.00 (0)	3.00 (0)	2.90 (.3)
IV. Some-all Relationships	[0-4]	2.69 (1.15)	2.81 (.81)	2.67 (1.07)	2.60 (1.11)
V. Multiple Class Membership	[0-4]	1.75 (1.48)	2.19 (.94)	1.60 (1.40)	2.00 (1.41)
VI. Class Addition	[0-2]	.69 (.57)	.44 (.61)	.27 (.45)	.40 (.66)
VII. Multiplicative Classification	[0-3]	1.31 (.85)	.75 (.57)	.80 (.66)	.60 (.92)

TABLE 5

Per Cent of Subjects Passing the Posttest Conservation Tasks

Experimental Group		Conservation Tasks: Number	Quantity	Area
Seriation Instruction	(N = 16)	25.0%	37.5%	31.3%
Classification Instruction	(N = 16)	25.0%	25.0%	18.8%
Combination Instruction	(N = 15)	13.3%	13.3%	13.3%
Controls	(N = 10)	20.0%	20.0%	20.0%

serving subjects were superior to their non-conserving counterparts, i.e., for the seriation scores cases: number conservation (25.64 vs. 20.30), $t(55) = 5.34$, $p < .01$; quantity conservation (26.0 vs. 20.79), $t(55) = 3.75$, $p < .01$; and surface area conservation (26.5 vs. 20.57), $t(55) = 3.95$, $p < .01$. The corresponding values for the total classification scores were: number conservation (13.93 vs. 10.74) $t(55) = 5.80$, $p < .01$; quantity conservation (14.67 vs. 10.94), $t(55) = 4.34$, $p < .01$; and surface area conservation (13.90 vs. 11.02), $t(55) = 5.80$, $p < .01$. The Pearson correlation coefficient between total seriation and classification posttest scores was $r = +.42$, $p < .01$.

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IV
Discussion

The major findings of this investigation may be briefly summarized. Specific transfer was clearly demonstrated for the seriation instructional condition and this was shown by the between-group posttest comparisons and the within-group pretest/posttest improvements for the seriation trained subjects. The most notable score increases occurred for the relative and successive comparisons and the multiplicative seriation subtasks. Although there were no significant differences among the various experimental conditions with regard to the classificatory measures, there was evidence of positive pretest/posttest change for children in the classification instruction condition. It may be noted that the only case of significant pretest-treatment effects concerned this dependent variable.

Minimal evidence for far transfer is shown in the present results. Only the pretest/posttest seriation total score increment for the classification trained subject provided evidence for nonspecific transfer of training effects. Seriation instructed children tended to perform better, although not significantly so, on the posttest conservation task settings.

The failure of present combined class/series instructional condition both in terms of curriculum specific transfer and far transfer (conservation tasks) is notable. In general, the posttest scores of these children differed little from those of their counterparts in the control condition. Acknowledging the age range of the present subject sample, the failure to find any evidence for training-related changes on the conservation tasks is contrary to the suggestions of Pinard and Laurendeau (1969). In retrospect, the noneffectiveness of the combined instructional condition could stem from the lack of repetition experiences which were provided in the comparison seriation and classification training groups. While the overall instructional duration was equal for all three training conditions, the children in the combined group received approximately two thirds of the structured program emphases on classes and series per se in comparison to the unitary instructional conditions. It may be that a certain amount of essential "redundancy" in their daily experiences is necessary for optimal cognitive growth insofar as children of this age range are concerned.

The present findings may be compared to a number of previous investigations. The efficacy of the seriation instructional program, at least in terms of curriculum-specific transfer, essentially replicates the earlier results of Hooper (1972). A lack of specific transfer for an approximately comparable classificatory instructional program was found by Shantz and Sigel (1967) and Sigel and Olmsted (1970). The latter study also failed to find evidence for far transfer to conservation tasks for a sample of 5- to 6-year-old, lower-class children. In comparison to the present results, the notable far transfer to conservation skills shown in the Shantz and Sigel (1967) and Sigel, Roeper, and Hooper (1966) investigations was based upon somewhat older samples at least insofar as the mental ages of the subjects are concerned. The failure of the present classificatory training sequences to significantly influence the children's performances on the complex class addition and inclusion tasks is perhaps understandable in view of the typical age norms associated with these tasks (cf. Brainerd & Kaszor, in press; Hooper, Sipple, Goldman, & Swinton, in preparation; Klahr & Wallace, 1972). The higher level tasks assessing class-additivity relationships are clearly linked to the developmental status of the target children and generally have not been readily modifiable via instructional programming (cf. Beilin, 1971; Klausmeier & Hooper, in press).

Viewed retrospectively, and in comparison

to the rather clearcut relationship between the seriation instructional sequence and related task settings, the rather disappointing results of the present classificatory instructional conditions probably are a function of the type of training and the particular dependent measures employed. As Wohlwill (1970) has pointed out, many concept training strategies may be differentiated in terms of orientations to vertical transfer (highly structured task-specific instruction) compared to horizontal transfer (highly generalized instruction). Structured experiences have proven to be effective in improving the class inclusion understandings of older children (e.g., Kohnstamm, 1967; Mouw & Hecht, 1973) although the generality and developmental significance of the resultant behavioral changes have been questioned (Inhelder & Sinclair, 1969). The present classificatory instructional conditions, in contrast, may be categorized as rather general in nature, i.e., the specific task requirements of the typical "some-all" and class inclusion tasks, for example, were not a major focus. Nonetheless, one could legitimately expect curriculum-specific transfer to be demonstrated for the resemblance, consistent, and exhaustive sorting tasks (although ceiling effects appear to be present for these subtasks; see Table 4). Insofar as the higher order class relationship tasks are concerned, the continued utilization of similar global classificatory instructional programs with children of preschool age appears questionable.

Further examination of the seriation and classification training sessions suggest differences in teacher and child-peer involvement for each group. The seriation sessions indicate a strong teacher role as questioner and stimulator in the use of materials by the children. The materials lend themselves to more imaginative and intriguing manipulation by children than the classification materials. This can be seen in the sample training session on page 5, particularly items 3 and 4. This type of manipulation increased the possibility for verbal exchanges of conclusions with peers. Peer affirmation or correction socialized the action and in turn served to promote further decentering of the child's thought. In addition, the internalization of action by the child and the restructuring of his thought was reinforced through the multiple arranging, disarranging, and rearranging of the materials. The purported increase in flexibility in use of materials and increased verbal exchanges was supported by teacher-trainer evaluations of the sessions. Both teacher and child seemed to find seriation sessions more enjoyable. The classification sessions on a whole indicate the involvement of the teacher and child to be more limited and the materials to be more closed ended in usage. Essentially these differences provide further evidence for understanding the differences in success of the seriation and classification trained groups and reveal the need for careful consideration of these variables in subsequent instructional settings.

As anticipated for Piagetian task performances, the high vs. low age subsample comparisons revealed a uniform posttest superiority for the older children. Instructional effects have been shown to be significantly related to the relative ages and associated developmental status of the target children, e.g., Beilin and Franklin (1962), Hooper (1972), Inhelder and Sinclair (1969), and Youniss (1971).

Initial consideration of the conserver vs. nonconserver seriation and classification score comparisons and the related intercorrelations suggest a unitary developmental pattern for logical reasoning skills as postulated by the Piagetian system. Overall, however, the implications of the present study suggest otherwise. Clearly, relationality concepts as represented by the present seriation task array are more easily modified via instructional programming than their classificatory counterparts. Recent evidence (Brainerd, 1972) indicates that relationality concept mastery precedes the emergence of complementary class concepts in task settings operationally derived from the logical groupements associated with the middle childhood subperiod. In analogous fashion, ordination understanding was found to precede natural number competence which in turn preceded cardination understanding, the classificatory ability domain (Brainerd, in press; Brainerd & Fraser, 1973). This pattern was further substantiated in a transfer of training analysis (Brainerd, 1973). The prior understanding of seriation concepts may represent a case of developmental precursors for subsequent classificatory and conservation concept acquisitions. Tentative evidence supporting this contention has been reported for the seriation/conservation case in a longitudinal analysis (Wohlwill, Devoe, & Fusaro, 1971). In general, the differential effectiveness of seriation instruction and the lack of far transfer effects in the present investigation suggest a nonunitary picture of cognitive functioning during the transitionary phase between preoperational and concrete operations period thought.

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