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ABSTRACT

This thesis reports a study of the effects of two types of advance organizer instruction, expository (EO) and guided self-discovery (GSDO), in teaching hierarchical classification or relations to preschool children. In the study, four experimental and one control group received three 25 minute instructional sessions. Using the same materials, experimental groups received either EO or GSDO instruction in classification or relations. Straightforward statements were made in EO instruction, and guiding questions were used in the GSDO lessons. In the control group, teachers used the same materials without the EO or GSDO teaching methods. Eight pre and posttests measured spontaneous classification, class inclusion, additive seriation, and one-to-one correspondence. Transfer tasks, administered six weeks after training, consisted of cross classification and cross seriation in a 3 x 3 matrix, spontaneous classification and one-to-one correspondence problem solving tasks, and conservation of area and number. Results indicated that both organizer groups outperformed the control group, and performance by EO groups was significantly superior to GSDO groups. The effectiveness of the EO method of instruction with preschool children was evidenced by the duration of training effects up to 10 weeks, and transfer task performance at 14 weeks after instruction. (Author/SB)

Technical Report No. 446

# THE EFFECTS OF TWO TYPES OF ADVANCE ORGANIZER PRESENTATION ON PRESCHOOL CHILDREN'S CLASSIFICATION, RELATIONS, AND TRANSFER TASK PERFORMANCE

by

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Report from the Project on
Studies of Instructional Programming
for the Individual Student

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I dedicate this work to my father, Merle Blue, who has been the most influential and inspiring teacher in my life.

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## ABSTRACT

The effects of two types of advance organizer instruction, expository (EO) and guided self-discovery (GSDO), were examined in teaching hierarchical classification or relations to preschool children. In this study a control group was taught in a traditional manner by the regular teacher, using the same materials as the experimental groups. Each group received three 25 minute instructional sessions. Eight pre and posttests measured spontaneous classification, class inclusion, additive seriation, and one-to-one correspondence. Transfer tasks consisted of cross classification and cross seriation (in a 3 by 3 matrix), spontaneous classification and one-to-one correspondence problem solving tasks, and conservation of area and number.

Results indicated that both organizer groups outperformed the control group, and that performance by EO groups was significantly superior to GSDO. Significant nonspecific transfer to relations tasks was demonstrated by the EO-classification group, while the EO-relations groups showed no significant transfer to classification tasks. No far-far transfer to conservation tasks was found for any treatment group. GSDO and EO methods were equally effective in teaching relations skills, while the EO method was superior to GSDO in teaching classification.

These results lend support to the asynchronous view of skill

development and are consistent with findings of a relations < classification order of skill emergence, with classification potentially subsuming relations. The effectiveness of the EO method of instruction with preschool children was evidenced by the duration of training effects up to 10 weeks, and transfer task performance at 14 weeks after instruction.

# I

# INTRODUCTION

## THE LEARNING AND DEVELOPMENTAL THEORIES OF AUSUBEL AND PIAGET

### Problem Statement and Chapter I Overview

The main aim of this study was to measure the facilitating effect of advance organizer lessons (Ausubel, 1960, 1963, 1968) for the meaningful discovery and reception learning of two "process concepts" (e.g., Lawton, 1977a); specifically, the intellectual operations of classification and relations as described in Inhelder and Piaget (1964). The more specific purposes of this research were threefold. The first, and primary purpose, was to compare the efficacy of two styles of advance organizer presentation (guided self-discovery versus expository) in teaching relations and classification. The second purpose of this study was to examine the order of acquisition or task difficulty of certain concrete operations, specifically, spontaneous classification, class inclusion, additive seriation, and one-to-one correspondence seriation. The third and final purpose of this investigation was to assess the effects of three types of transfer: near-near, near-far, and far-far (e.g., Brainerd, 1975).

A summary of Ausubel's theory of meaningful learning and retention [illegible] presented first, followed by a discussion of certain aspects of Piaget's theory of intellectual development. Chapter I concludes with a comparison of Ausubel and Piaget's theories of intellectual development and learning.

Ausubel's Subsumption Theory of Learning

Ausubel views cognitive structure as composed of hierarchically organized facts, concepts, and principles. Central to Ausubel's subsumption theory of meaningful learning (1963, 1968, 1969) is the hypothesized non-arbitrary or sensible relationship between new knowledge and that already in cognitive structure. Assimilation of new knowledge occurs when subordinate concepts and factual information are subsumed into previously learned superordinate concepts and principles, to which the new knowledge is related in a nonarbitrary way. Such a subsumption process depends upon the prior establishment of high-order concepts and principles in cognitive structure (Lawton & Wanska, 1977a).

Ausubel defines assimilation as "the storing of newly acquired meaning in linkage with the anchoring idea to which it is related in the course of learning" (Ausubel & Robinson, 1969, p. 603). Such meaning, over time, tends to become dissociated or separated to varying degrees from the original anchoring idea. The dissociability strength of new ideas is essential to the retrieval of ideas. The strength of initial anchorage potentially facilitates dissociability in terms of: 1) clarity and stability of anchoring ideas, 2) the relationship the anchoring ideas have to the new concept, 3) the discriminability of new ideas from those already in cognitive structure which may subsume them (Ausubel & Robinson, 1969, p. 112). For meaningful learning to occur, at least three conditions are required. First, appropriate potential subsumers must already be in the learner's cognitive structure. Second, new knowledge must be relatable and discriminable from ideas already in cognitive structure in a non-arbitrary and substantive way. Third, the learner must have both the ability and the desire to relate the new ideas to those already in cognitive structure.

Ausubel (1969) defines conceptual meaning as the product of a learning process, during which logically and psychologically meaningful material is incorporated into cognitive structure. He proposes four kinds of meaningful learning; representational, conceptual, propositional, and discovery. A first and primitive type of understanding is that symbols can be used to designate objects; one such symbol may be a word used to label an object, event, or related objects and events in a child's environment.

Conceptual learning refers to the ability to group phenomena together according to criterial attributes which are shared by all members in a group or class and serve to distinguish these members from those of other groups. For Ausubel, concept learning requires logical and psychological meaning. The latter item refers to the learner's ability to judge whether an instance encountered is an exemplar or nonexemplar of a given concept (Ausubel & Robinson, 1969, p. 61). Such ability is based on previous experiences or encounters. Ausubel further distinguishes between the formation of a concept in which the concept is a representative image of criterial attributes for a given class, and the naming of a concept with a spoken or written symbol representing an already acquired concept. Concept naming, according to Ausubel, comes later developmentally, with both denotative and connotative meanings being given to concepts. Meaningful concept naming also comes after concept formation in the sequence of learning. It is possible, of course, for the learner to be introduced to a concept label before meaningfully learning the concept.

Propositional learning, the third type of meaningful learning described by Ausubel, deals with the relations between concepts and ideas. Propositional learning entails the understanding of generalizations, relations between concepts, and syntactical rules for combining words into sentences. Ausubel discusses several types of relationships which are facilitated by propositional learning, including subordinate, superordinate, and combinatorial relationships (Ausubel & Robinson, 1969, pp. 65-68).

The final type of meaningful learning considered by Ausubel is discovery. In discovery learning the learner is required to rearrange, reorganize, or transform information during the learning process. Ausubel states that the essential feature of discovery learning is that the material to be learned is not given in final form but must be independently discovered and reorganized by the learner before he can internalize it (Ausubel, 1961, pp. 69, 605). The learner must rearrange or transform the information in some way to integrate it with existing knowledge in his cognitive structure, to create a desired end product, or discover a missing means-end relationship. At this point "the discovered content is internalized just as in reception learning" (Ausubel, 1961). Discovery learning potentially calls upon the three processes previously described. Discovery learning, for Ausubel, can play a key role in concept formation, inductive learning, problem solving, and creativity. There are, however, certain limitations to, or restraints on, the use of discovery learning which will be discussed in the next section.

When learners attempt to remember a concept or proposition they may attempt to meaningfully relate new material to existing ideas in cognitive structure, or merely attempt to memorize new information without relating it to what is already known. A distinction is made by Ausubel between two interdependent dimensions of the learning process, the reception (versus) discovery and meaningful (versus) rote dimensions. Four potential processes of learning combining these dimensions are hypothesized: meaningful-reception, rote-reception, meaningful-discovery, and rote-discovery.

In reception learning, the entire content of what is to be learned is given in its final form, and the learner is required to remember the specially prepared general ideas. In discovery learning, the principle content is not given, but must be discovered by the learner.

Reception and discovery learning can be either meaningful or rote. Both types of learning will be potentially meaningful if the material can be related in a substantive and nonarbitrary way to cognitive structure which the learner already possesses. Ausubel considers learning to be rote when 1) it lacks meaningfulness (or is related in an arbitrary or nonsubstantive way to existing ideas), 2) the learner lacks the relevant anchoring ideas or subsumers, and 3) the learner lacks a meaningful psychological learning set. In other words, if the learner merely attempts to memorize a new idea, without relating it to existing ideas, rote learning takes place, irrespective of whether it is acquired receptively or discovered. It is also important to remember that rote learning will occur under these circumstances even when the new knowledge is itself potentially meaningful.

The advantages of meaningful learning over rote have been supported by empirical evidence, as well as defended upon logical or theoretical grounds (e.g., Avital, 1968; Bransford & Johnson, 1972; Gagne & Smith, 1962; Krueger, 1929; Mayer, 1975; Roughead & Scandura, 1968; Wittrock, 1966, etc.). In the investigation reported here the advantages of meaningful learning are taken as a given and the emphasis is on the comparison of two types of potentially meaningful learning, reception and discovery.

Reception and Discovery Learning

Ausubel has argued the merits of meaningful learning, both reception and discovery. Ausubel assumes that the majority of learning both in and outside the classroom will be reception rather than discovery, with a great deal of expository teaching taking place (especially in the school setting). He states that it is economical to initially present new material to the learner in approximately final form (Ausubel & Robinson, 1969, p. 96). This knowledge provides the learner with a structure of superordinate concepts and principles. The learner, at this point, has the potential, in the form of subsumers, for incorporating new related knowledge into cognitive structure in a meaningful fashion.

Ausubel argues the case for meaningful reception learning against the popular assumption that most reception learning is passive and rote. Ausubel makes the point that while a young child's learning is manifestly dependent upon concrete experience, it does not necessarily follow that only by making personal discoveries will meaningful learning occur.

Countering the frequent criticism that reception is a passive, rather than active process, Ausubel points out that meaningful reception learning is by necessity an active process. The learner must attempt to meaningfully relate and retain the structure, propositions, and concepts which are initially presented. There is also a subsequent stage when new and more particular knowledge must be non-arbitrarily related to cognitive structure for it to be meaningful. Thus "meaningful reception learning involves more than a simple cataloguing of ready-made concepts within cognitive structure," (Ausubel & Robinson, 1969, p. 100).

Ausubel further explains the type of activities required for reception learning to be meaningful. First, a judgment must be made by the learner. Second, some reconciliation and differentiation of new and similar established ideas must occur, with new propositions often reformulated to blend into the learner's personal frame of reference. Finally, if reconciliation between apparently contradictory ideas cannot be achieved, the learner may attempt to synthesize or reorganize existing knowledge under more inclusive or broadly explanatory principles (Ausubel & Robinson, 1969, p. 100).

Meaningful reception learning activities are considered by Ausubel to be qualitatively different from those involved in discovery learning, in that reception learning is limited to the assimilation and integration of presented ideas, as opposed to discovering them independently. He states, however, that either simple verbal explanations or a form of guided self-discovery, aided by the judicious use of prompts and hints, is adequate for teaching relatively simple new ideas at the concrete operational stage of cognitive development (Ausubel & Robinson, 1969, p. 483):

When the tasks become more difficult and unfamiliar, Ausubel suggests that a more autonomous discovery learning approach may enhance intuitive meaningfulness by intensifying and personalizing the experience and operation of generalizing from empirical data. However, this phase of learning would be dependent upon prior concrete empirical learning, and upon the individual's disposition towards this form of learning.

Ausubel (1964, p. 290) disputes the popular assumption that all discovery and problem-solving experience is inherently and necessarily meaningful, arguing that "the deference to authority implied in accepting already discovered relationships has been condemned out of all reason" (1969, p. 261). On this matter Ausubel broaches the efficiency issue, stating, "If students were required to independently validate every proposition presented...before accepting it, they'd never progress beyond the rudiments of any discipline" (ibid., p. 291). Ausubel also warns against rote discovery learning, which may occur when discovery experiences lack understanding of the substantive underlying principles or concepts (Ausubel, 1964, p. 291).

Although Ausubel agrees that meaningful discovery methods may enhance the learning, retention, and transferability of principles under certain conditions, he feels that "students do not independently have to solve the problems...in the content of learning materials for the solutions to have meaning and transferability" (Ausubel, 1969, p. 261). He acknowledges the need for further research, since most findings have been inconclusive due to confounding factors. While giving credence to the potential advantages of discovery learning, Ausubel considers none of these arguments to outweigh the fact that discovery or problem-solving methods are far more time-consuming than expository presentation. Though Ausubel feels that problem-solving abilities are important to encourage, he feels that "pure" discovery learning is inefficient, impractical, and often unfeasible. He feels the overemphasis of problem-solving might defeat its purpose, with learners denied sufficient time to master the content of a given subject matter area, and, as such, unable to solve simple problems requiring the application of such content. A further limitation of discovery learning cited by Ausubel concerns the fact that fewer individuals possess or can be easily taught problem-solving skills or qualities than those who can easily comprehend verbally presented materials (Ausubel, 1969, p. 262).

Returning to the efficiency issue, Ausubel feels that these disadvantages apply to both "pure" and guided or "arranged" discovery approaches (Ausubel, 1969, p. 279). Ausubel disagrees with the overemphasis on problem-solving as opposed to acquisition of knowledge (e.g., Bruner, 1957, 1961; Suchman, 1961, etc.) and feels that the time judgment should favor meaningful transmission of subject matter. Another disadvantage of discovery learning for young children is the subjectivity of children's evaluation of external events, and their tendencies to jump to conclusions, generalize from limited experience, and consider only a single aspect of a problem at a time (Ausubel, 1969, p. 280; see also, Lunzer, 1973). Such tendencies are viewed by Ausubel as further increasing the time-cost of discovery learning.

In general, then, Ausubel feels that the discovery approach offers no indispensible learning advantage, whether practically, developmentally, or in terms of transferability to other subject matter areas or in terms of efficiency concerns.

Ausubel's description of the "stage" concept, and how it relates to the subsumption theory of learning is now briefly described. It is the second stage, namely that of "concrete operations" which is most pertinent to this study.

Ausubel's Stages of Cognitive Development

Identifying the developmental stage of the learner and relating the learning situation to this is considered of critical importance to Ausubel (Ausubel & Robinson, 1969, p. 175). Ausubel's stages of intellectual development share the structuralist view of Piaget that qualitative changes in cognitive abilities occur as a developmental phenomenon. Differences in the two stage models will be discussed in an upcoming section.

Ausubel describes three stages of development based idiosyncratically on Piaget's stages of intellectual development. These are, pre-operations, concrete operations, and abstract operations. At the pre-operational level, children are said to be capable of acquiring primary concepts, when the appropriate concrete exemplars are provided. For example, the concept "mammal" can be learned when adequate examples of mammals are provided and critical attributes pointed out (e.g., repeating "this is a mammal because it has hair," etc. for many exemplars).

Following the acquisition of primary concepts, propositions containing such concepts can be understood. For example, "all mammals have hair on their bodies" can now be understood. This period also marks the onset of the formation of mental images, although the child's cognitive processes still tend to be dominated by perception of real objects and events.

The concrete operational level is characterized by the child's ability to acquire a concept via a verbal definition, as long as this is accompanied by concrete exemplars, which may be words representing examples of attributes or examples of a concept, in addition to tangible non-verbal props (Ausubel & Robinson, 1969, p. 187). At this stage, the learner no longer needs to abstract criterial attributes from exemplars, but can utilize the exemplars in the comprehension of the concept. For example, a concrete-operational child can comprehend the statement "a dog is one kind of mammal" without exemplars of mammals being shown or manipulated. The child could also identify a novel stimulus (e.g., a lynx) as a mammal, based on the abstraction "all mammals have hair." Such concepts would be considered "secondary abstractions," since the learner did not have to abstract the attribute which made the dog or lynx a mammal, but could construct a representative image of mammals, based on the defining criterial attributes learned in the past.

Thus, concrete-operational thinking is somewhat intuitive, with the child capable of understanding semi-abstract relationships at a rather simple level and only with accompanying concrete props or verbal definitions (which have been demonstrated via such props). The most crucial factor in the child's progression through concrete operations is the increasing independence of thought from concrete props. The amount of independence is determined to some degree by the subject matter area in which the child is reasoning.

The final stage of cognitive development described by Ausubel, abstract logical, is marked by the learner's ability to relate the criterial attributes of a concept directly to cognitive structure without props, though definitions of unfamiliar terms may be needed (Ausubel & Robinson, 1969, p. 187). In other words, the learner can now utilize or combine existing ideas in comprehending a new concept or definition. This period is further marked by the ability to understand propositions involving secondary abstractions and the relations between them (ibid, p. 603). For example, the statement "A tiger is a meat-eating member of the cat family of mammals, of a tawny color, striped with black" can be understood without exemplars, and so long as terms like "cat family" and "meat-eating" (carnivorous) have been adequately defined.

Ausubel states that although children are capable of "if then" thinking as early as the pre-operational period (e.g., "If I am good, I will get a treat; I was bad, so I will not get a treat," etc.), it is the degree of abstraction and not the kind of logical process which distinguishes the stages of cognitive development. Thus, a feature of the abstract logical stage is that "if then" thinking involves the use of secondary abstraction, not of being dependent upon empirical experiences <u>such as the primary concepts used in pre-operational and operational "if then" reasoning</u> (Ausubel & Robinson, 1969, p. 188) (author's emphasis added).

As an educational psychologist, Ausubel views the gradual shift from concrete to abstract functioning as the most important developmental intellectual change, with the movement between stages requiring increasing independence from concrete props in specific subject matter areas, with thinking becoming more abstract. This approach is contrasted with Piaget's interpretation of stage changes as related to the underlying mental operations or ways of thinking, which are seen as changing qualitatively with development. In other words, Piaget also posits the increasing independence from concrete props as indicative of intellectual changes, but in terms of the types of operations (e.g., classification, relations, conservation, transitivity) which are performed on them.

The crucial aspect of the concrete operational state, for Ausubel, is the child's ability to comprehend concepts when presented a verbal definition including criterial attributes, as long as concrete exemplars of one or more of these attributes are initially provided (Ausubel & Robinson, 1969, p. 185).

One of the critical differences between Piaget's and Ausubel's stage theories is the role of learning as it relates to the cognitive readiness of the learner. Piaget considers readiness to be synonymous with maturation (Sullivan, 1969), with learning or experiential factors unable to explain development, though developmental factors may partially explain learning. In contrast, Ausubel contends that stages of intellectual development result from both a process of maturation and cumulative prior learning, with primary emphasis placed on learning. According to Ausubel, learning is crucial to the attainment of a "stage." However, he acknowledges that the rate at which different types of learning occur is very probably limited by a maturational factor.

Ausubel proposes that intellectual development and attainment of cognitive stages can be accelerated, to a limited extent. The optimal period for acceleration, in his view, is when the child is at a critical threshold level in thinking. That is, when thinking is minimally affected by the dominant mode of thought associated with the stage the child has been passing through, and is coming under the influence of the mode of thinking at the subsequent stage. Ausubel further emphasizes the importance of the quantity and appropriateness of related experiences in determining the rate of development.

Due to an "uneveness in an individual's experience and abilities," Ausubel does not expect the stage transition to occur simultaneously in all areas (Ausubel & Robinson, 1969, p. 183). It is hypothesized that transitions will occur at varying times in different subject matter areas, and be affected by tasks, the learner's familiarity with related concepts, or specific capabilities. For example, the transition to abstract thinking might occur earlier in science than in social studies, if the learner had been using more ideas about mass, time, and events than ideas about historical events, social institutions, etc. (ibid, p. 183). Within the content of Ausubel's learning theory, how the meaningful learning of one concrete operation affects the learning of others remains an open question. Though sharing a qualitative stage model, with the Genevans, based on the child's predominant mode of intellectual functioning, Ausubel does not share their assumption of synchronous development or complete acceptance of structures-of-the-whole (e.g., Lawton & Wanska, 1976).

Transfer in the Ausubelian Model

In Ausubel's learning theory, meaningful learning and transfer are virtually synonomous terms, as his description of the concept of assimilation makes clear. Transfer is facilitated by the unifying structure of subject matter (Lawton & Wanska, 1977a). Other developmental theories (e.g., Inhelder & Piaget, 1958) or learning theories (e.g., Kendler & Kendler, 1956) describe transfer as a crucial concept in analysis of stage-related operations or learned behaviors. The concept of transfer has important implications for the present investigation, as well.

The Genevan position views the development of stage-related skills in terms of horizontal decalage and structures-of-the-whole (see pages 30-31 for further discussion). Horizontal decalage refers to the individual phenomenon of different levels of achievement in terms of problems involving similar mental operations. Such decalage represents a lack of immediate transfer, with the ability to perform the related operations emerging over a period of time (Ginsburg & Opper, 1969). Structures-of-the-whole is used by the Genevans to describe an array of cognitive abilities at a given stage of development. In this framework, the structures defining a stage emerge synchronously, with much transfer expected. For example, a concrete operational child might be expected to exhibit conservation, class inclusion, and transitivity at the same time (i.e., synchronously), with the absence of such transfer indicating either a type of decalage or stage-transitional reasoning abilities.

In contrast to the Genevan assumptions about transfer, various learning theory positions have received empirical support for their contention that transfer is mainly training specific. Brainerd (1975, pp. 371-372) describes three types of transfer entailed in structures-of-the-whole: near-near, near-far, and far-far. Near-near transfer refers to generalization of a specifically taught skill (e.g., conservation of number) to materials not used in training. Near-far transfer consists of generalizing the principle to new content areas (e.g., other types of conservation, such as area or length). Far-far transfer consists of improvement of same-stage reasoning skills which do not involve the operation taught (e.g., transitivity or class inclusion). Although the learning theories previously mentioned predict some degree of near-near and near-far transfer, they do not predict far-far transfer, a prediction unique to structures-of-the-whole (Brainerd, 1975).

Ausubel addresses his theory to basically three types of transfer, roughly parallel to the types described by Brainerd (1975). The first type of transfer is sequential (near-near), with transfer of a principle to new materials, which are sequentially related to the original learning experience (e.g., learning that all objects can be grouped together which share attributes previously learned). The second type of transfer considered by Ausubel is lateral (near-far), which occurs when a learned concept or principle in one content area is applied to a new content area (e.g., learning acquired in one subject matter setting is applied to another, or non-school context). The third type of transfer is vertical (far-far), in which prior learning at one level in a hierarchy influences present learning at a higher level (e.g., a child might use the concept of hierarchical classification to discovery or comprehend the general concept of classification or to solve problems requiring concrete operational concepts).

Since Ausubel's forms of transfer refer to subject matter, and Brainerd's to skills or logico-mathematical operations, the pairing of the two transfer models presents an interesting distinction of emphasis on what is the source of transfer. For example, Brainerd's near-far transfer refers to related skills or sub-components of skills (e.g., length and volume conservation), whereas Ausubel's lateral transfer refers to new content areas, which share underlying principles or generalizations, but which may greatly differ in content. Such differing content areas could require a similar cognitive skill, though this is not made explicit by Ausubel's definition of lateral transfer.

The greatest discrepancy between Ausubel's and Brainerd's transfer terms is in the meanings of vertical and far-far transfer. For Brainerd, far-far transfer extends from one skill to another same-stage skill, without requiring a hierarchical relationship between the two. Ausubel's vertical transfer, however, is described in hierarchical terms, with learning at one level influencing learning at a higher level. Whether this need be limited to one skill or subject matter area needs clarification. If, for example, the skills defining concrete operations are thought of in terms of a hierarchy (based, at least in part, on the empirical evidence for an order of skill emergence), Ausubel's vertical transfer could more closely approximate Brainerd's far-far transfer. Following this argument a step further, teaching a higher order classificatory skill could facilitate far-far transfer to either lower order skills (e.g., seriation) or higher order skills (e.g., classification and seriation problem solving tasks).

Ausubel considers sequential transfer to be most prevalent. A key factor in sequential transfer is the degree of discriminability between new ideas and those already in cognitive structure. Ausubel assumes there is a tendency for new ideas to be considered identical to existing knowledge, thus creating the potential for ambiguity in meaning. The discriminability of new learning is viewed as a function of the clarity and stability of existing ideas, to which new learning can be related. Ausubel suggests that as clarity and stability increase so should discriminability and, therefore, learning and retention (Ausubel & Robinson, 1969, p. 149). Sequential transfer can be facilitated, via teaching, by directly manipulating cognitive structure through unifying concepts and propositions which have the wider explanatory powers. The importance of the organization of presented materials is also considered critical to the facilitation of sequential transfer, with the first major task considered to be the identification of general ideas forming the structure of a skill or subject matter area (Lawton & Wanska, 1977b).

Lateral transfer, as previously described, occurs when a concept or principle in one content area is applied to a new content area. Ausubel's lateral transfer can be differentiated from Piaget's description of horizontal decalage in that it is related primarily to specific subject matter learning and may occur following teaching. Piaget's use of decalage refers to stage-related operations (e.g., seriation, conservation, etc.) which are thought to unfold as a function of development, and not training. Ausubel states that lateral transfer can be facilitated by stressing the underlying principles and generalizations, and using subject matter content as a vehicle for training transferable content, which may be applied to a number of other areas (Ausubel & Robinson, 1969, p. 151). On this point Ausubel emphasizes the importance of the meaningfulness of the original learning; without this, there is little "transfer value."

Ausubel views vertical transfer, which is said to occur when learning at one level in a hierarchy influences present learning at a higher level, as enhancing the acceleration of a developmental stage. However, the degree to which lateral and vertical transfer can also be expected to improve following teaching is not particularly clear from Ausubel's writings. To facilitate vertical transfer, Ausubel recommends a task analysis process, to insure that the necessary underlying skills are meaningfully learned. In Genevan theory, vertical decalage is a process of development which occurs over time. Such development enables the child to master tasks at increasingly higher levels both within and between stages. The Piagetians do not expect such transfer to occur following training.

The present investigation examined all three types of transfer described in this section. It was predicted that sequential transfer (near-near) to materials not used in teaching sessions would occur following a series of advance organizer lessons in each skill area tested. For example, children taught hierarchical classification were expected to show transfer to materials used in testing spontaneous classification and class inclusion, with the latter a more complex form of transfer.

It was further predicted that some lateral (near-far) transfer would occur (e.g., children taught in one skill area, such as hierarchical classification, would show superior performance on cross-classification and classification problem-solving tasks). Little vertical (far-far) transfer was predicted, with the expectation that children taught relations would not show improved performance on classification tasks, and that none of the groups would exhibit conservation of area or number. One exception to this prediction of little far-far transfer concerned those taught to hierarchically classify. It was expected that these children would show superior performance on seriation tasks, including the cross seriation task.

## Advance Organizers

To facilitate the hypothesized process of meaningful subsumption learning and promote sequential transfer, Ausubel (1960, 1963, 1968, 1969) recommends the use of advance organizers (AOs), or deliberately prepared sets of related ideas which are presented to the learner in advance of and at a higher level of abstraction than subsequent learning material. The primary purpose of organizers is to insure the availability of relevant anchoring ideas, to which new ideas can be related. Thus, the concepts contained in organizers should be stable and discriminable from concepts already in the learner's cognitive structure. Knowledge in an organizer has a superordinate relationship to subordinate concepts or specific facts presented in subsequent material (Ausubel, 1963; Ausubel & Robinson, 1969), with the effectiveness of organizers related to the subsumption process of meaningful learning. Thus, AOs facilitate the meaningful hierarchical organization of new concepts, which become potential subsumers for related subordinate concepts (Lawton & Wanska, 1977a).

Ausubel cites three ways in which AOs facilitate retention and transfer: (1) by establishing general ideas as the anchorage for subsequent learning; (2) by providing related structure through general propositions under which subsequent, particular information may be subsumed; (3) by eliminating rote learning. Organizers accomplish the above, first, because the learner is not required to learn unfamiliar new material, and secondly because learning activities occur in related sequences.

Advance organizers are usually presented via verbal propositions, which may be accompanied with a number of concrete props, appropriate to the age or competency of the learner (Ausubel & Robinson, 1969, p. 166). Ideas in AOs should be constructed so that the individual can learn the concepts involved in a meaningful way. That is, the ideas presented should be relatable to existing ideas in the learner's cognitive structure in a non-arbitrary way. If the learner does not have such a meaningful understanding of the prerequisite concepts, the AO loses its potential meaningfulness, and learning is likely to become relatively rote.

It is important to further specify the purpose of an organizer. Its function is not merely to relate learning materials to cognitive structure, but to "induce, through a particular kind of learning, organizing and explanatory concepts, propositions, and principles. The organizer is not, therefore, an intermediary catalyst between existing cognitive structure and new knowledge, but becomes cognitive structure itself during an initial learning process" (Lawton & Wanska, 1977a).

The potential benefits of advance organizers are based on the principle that the most general and inclusive ideas should be presented first and then progressively differentiated in more specific detail, a process termed "progressive differentiation" by Ausubel (Ausubel & Robinson, 1969, p. 167). This principle rests on two assumptions. First, Ausubel assumes that it is easier for learners to grasp the differentiated components of a previously learned whole than to form such a whole from differentiated parts. Second, that the learner's personal cognitive organization of content is arranged in a hierarchical fashion, with the most inclusive ideas subsuming the more specific, differentiated ones (Ausubel & Robinson, 1969, p. 168).

A distinction is made by Ausubel between expository and comparative organizers, with the former employed when the material to be learned is completely unfamiliar, and the latter, when the materials are not completely new. After establishing whether the learner had any relevant knowledge already in cognitive structure, an expository organizer would utilize higher general and inclusive statements, including whatever relevant knowledge already existed in the learner's cognitive structure. This type of organizer would have a combinatorial effect, relating new knowledge and its details to cognitive structure (Lawton & Wanska, 1976a). A comparative organizer clarifies the similarities and differences between the meaningfully organized ideas already in cognitive structure and the new materials to be subsequently learned.

Ausubel distinguishes between organizers and overviews or summaries. These latter are seen as presenting material at the same level of abstraction, generality, and inclusiveness. They achieve their effectiveness by presenting simplified materials, with key concepts of low inclusiveness, or by repetition (Ausubel & Robinson, 1969, p. 316). Although learners may independently construct general concepts, acting as potential subsumers, Ausubel considers this neither likely nor efficient.

Ausubel's distinction between organizers and overviews or summaries lacks clarity. The need for a succinct, operational definition of an organizer still exists. Some clarifications of Ausubel's description have been provided in the literature. Hartley and Davies (1976) describe AOs as more complex than overviews, with the potential of providing a conceptual framework for clarification of the task ahead. Whereas overviews and summaries provide a synopsis of the learning task content, organizers are process-oriented, furnishing a broad framework, as opposed to a limited, specific outline. Finally, in an organizer the emphasis is placed on context, rather than content, with the organizer better thought of in terms of function than appearance (Hartley & Davies, 1976, p. 244).

Thus, to qualify as an advance organizer, the learning situation must: (1) provide an ideational framework for the more differentiated or specific task, (2) increase the discriminability of the task from related ideas already in cognitive structure, or (3) effect integrative reconciliation at a higher level of abstraction, generality, or inclusiveness than that of the learning material itself (Hartley & Davies, 1976, p. 246). Unless one or more of the above functions are either directly or indirectly fulfilled, learning is more likely to become rote, with a memory loss.

Lawton & Wanska (1977b) point out some semantic differences that might occur in interpreting Ausubel's distinction between organizers and overviews. They emphasize the necessity of knowing what form phrases such as "key words" and "central concepts" might take. They also state the need for specification of the nature of "overviews." Adding to the confusion of terms, Ausubel describes an organizer as providing "a general overview of the more detailed material" (Ausubel, 1963, p. 29). Lawton and Wanska (1977a) also suggest that attempts at merely restating Ausubel's definitions of organizer and overview only highlight the problem of adequately identifying the nature and structure of an organizer. The concept of organizer requires further clarification, especially as it might be applied to the teaching of young children.

## Piaget's Theory of Intellectual Development

Piaget employs a structuralist model of cognitive development to account for the qualitative changes in cognitive abilities. Structure, for Piaget, consists of a system of potential transformations of content and a set of laws applying to the whole system (Lawton, Saunders, & Muhs, 1976). Piagetian structures are defined by processes for forming relationships among bits of information, with minimal concern for specific information.

For Piaget, knowledge refers to developmentally changing schemas for interpreting the environment. Such schemas require both interaction with the environment and self-construction. Piaget views cognitive growth as changes in the systems and logic of thought. In this view, all information is processed in accordance with a system in which the individual is presently functioning. In this system of development, new logical rules qualitatively change previous ones; for example, the logic of concrete operations supercedes that of the preoperational stage.

Organization and adaptation are, for Piaget, the two critical aspects of intellectual development. Organization refers to the tendency to organize and integrate structures to adapt to the environment. Adaptation is discussed in terms of two functional invariant processes, assimilation and accomodation. Assimilation occurs whenever input is changed to fit the existing internal structure (i.e., is incorporated). Accomodation is the necessary complementary process of altering internal structure(s) to fit the newly assimilated input (Mayer, 1977, p. 175). Thus, learning new information involves cognitive structuring of logical operations.

## Piaget's Stages of Cognitive Development

Piaget's stage model assumes an invariant sequence of intellectual development, divided into four major stages: sensorimotor (0-2 years), preoperational (2-7 years), concrete operational (7-11 or 12 years), and formal operational thought (adolescence through adulthood). Since the present study dealt with the teaching of concrete operational skills to preschool children, the preoperational and concrete operational stages will receive primary attention.

The preoperational stage is initially egocentric and relies on action thinking. Piaget sees the child at this stage as unable to form true concepts. One object or event is frequently considered to have more than one identity, as the child centers on single characteristics, unable to consider several dimensions of an object simultaneously. This reasoning from one specific to another, transductive reasoning, as it is called, often leads to false determination of cause-effect relationships.

As the child enters the second phase of preoperational thought (between four and seven years), there is more evidence of symbolic thinking, with grouping based on elementary relationships becoming possible, and "regulations" beginning to replace irreversible thinking (i.e., the ability now to cancel an action by a reverse action). At this stage rules given by children for groupings of objects they have constructed are still intuitive and rarely verbalized, with such groupings usually still limited to a single dimension. The preoperational child also begins to understand relationships based on numerical order.

When the child enters the concrete operational period, representational actions develop into complex logical systems, with operations being performed on concrete objects or events in an increasingly consistent manner. Several operations emerge during the concrete operational stage. One important operation is transitivity, or the passage from one state or point to another along a perceptual continuum, an operation considered to have a critical relationship to such skills as seriation. Seriation of observable properties is also considered the concrete-operational forerunner of understanding formal transitivity (Murray & Youniss, 1968).

During the later stages of concrete operations, the child can also classify objects by various criteria, as well as understand the hierarchical sub- and superordinate class relationships that objects or events may have. These operations are still considered "intuitive," however, since their success is dependent upon concrete situations (Inhelder & Piaget, 1964). Another combinatorial ability emerging at this stage is class inclusion, which enables the part and whole (of a part-whole) relationship to be considered independently. Class inclusion frequently requires the child to ignore salient, misleading cues, and enables the child to classify objects and events into multiple classes.

Other concrete operational abilities include reversibility, equivalence recognition, conservation, and associativity. Piaget does not imply that the concrete operational child consciously uses these rules, but that thought is governed by them.

The formal operational period is characterized by the ability to perform mental operations not only on concrete objects but also on symbols. During this period the child develops the ability to think in terms of the hypothetical, in terms of probabilities, and the possible rather than the present givens. Piaget has never himself acknowledged the possibility of young children engaging in some form of simple problem-solving (e.g., if then thinking). He has stated (e.g., 1928, 1929) that, until early adolescence and the onset of formal reasoning, a child is not able to deal with causal reasoning and proof. However, research by neo-Genevans and others has led to the conclusion that young children may be able to deal with simple forms of problem solving. In spite of such investigations (limited, in comparison to research on concrete operations), the problem solving picture remains unclear.

The Genevan Structures-of-the-Whole Hypothesis

As previously mentioned, Piaget has stated that cognitive abilities within a given stage develop hand-in-hand. It is assumed that various abilities associated with each Piagetian stage all presuppose one or more members of a set of abstract intellectual structures, which actually control thinking (Brainerd, 1975). The structures-of-the-whole concept relates to the prediction that the cognitive abilities associated with each of Piaget's stages would emerge in synchrony, with the "order" of emergence considered basically idiosyncratic to a given child, and not consistently generalizable to any "typical" order of skill emergence (e.g., Flavell, 1963; Pinard & Laurendeau, 1969; Wohlwill, 1963).

Piaget's view of within-stage development has had several differing interpretations. Beilin (1965) points out that Piaget distinguishes between the sequential order of stages and achievements within a stage, asserting the fixed order of development, but denying the simultaneous development of several cognitive systems within a general stage. In addition, Piaget has acknowledged that performance can be affected by changing materials (Inhelder & Piaget, 1964, p. 110). Beilin (1965) further discusses the paradoxical, if not contradictory, Genevan interpretation of the same data as inferring both structural invariance and response variability. Although neo-Piagetian researchers have considered the probability of consistent within-stage orders of skill emergence or development, Piaget has not considered it probable for the individual stage-defining structures to emerge in the same order for all children (Brainerd, 1975).

Decalage and Transfer in the Piagetian Model

An exception to the rule that stage-characteristic skills must emerge synchronously is Piaget's concept of horizongal decalage, which describes the possibility of the asynchronous emergence of a single skill in more than one content area (Brainerd, 1975). Horizontal decalage is employed by Piaget to account for lack of immediate transfer, resulting in a child's different levels of achievement regarding problems which involve similar operations (Ginsburg & Opper, 1969, p. 165).

As previously cited, Brainerd (1975) describes three types of transfer entailed by the structures-of-the-whole model: near-near, near-far, and far-far, with far-far transfer unique to this model. As Brainerd states, "It is only in virtue of the assumption that prima facie dissimilar skills such as conservation and transitivity presupposes the same set of tightly knit cognitive structures that far-far transfer follows," (1975, p. 372).

This, in accordance with Piagetian theory, a child in the concrete operational period should show mutual far-far transfer between (or synchronous development of) the stage-defining skills; seriation, hierarchical classification, transitivity, and conservation, in addition to across-materials (near-near) and across-content (near-far) transfer. Such a position requires a number of empirical questions to be asked. As previously mentioned, one objective of this investigation was to address the structures-of-the-whole question.

Piaget's Position on Training and Acceleration

In contrast to learning theories such as Ausubel's, which predict facilitation of skill-defining abilities with instruction and experience, Piaget has viewed training attempts as theoretically futile. The Genevan assumption has been that unless, for example, a range of concrete operations are present following training (with endurance and generalization in evidence), training has not been successful, but merely task specific. Since stage achievement has the child or learner as locus, experimental attempts at acceleration of a stage contradict the basis of Piaget's constructivist position.

Training studies coming out of the Genevan School have, therefore, been designed within the framework of Piaget's theory of cognitive development (Inhelder, Sinclair, & Bovet, 1974). Piaget states (ibid) that three questions remain open regarding the theoretical implications of the various results of the different training methods. First, is the progress obtained via training stable, or does it disappear with time? Second, are the observed accelerations accompanied by deviations from the general developmental trend? Thirdly, and considered most important by Piaget, can progress obtained other than by natural development serve as a basis for new spontaneous constructions, or will the subject require the help of an adult to learn and progress?

Comparison of Ausubel and Piaget's Developmental Theories

Although both Piaget and Ausubel employ a structuralist stage model of cognitive development, the major differences lie in the type of internal structure postulated, the process by which changes occur, and the types of learning considered pertinent to specific changes occurring with growth. In contrast to Piaget's view of structure, which shows little concern for specific information, Ausubel views organized facts (or concepts) in a particular subject matter area as the components of cognitive structure.

Further differences pertain to the interpretation of knowledge held by each theory. As previously mentioned, Piaget describes knowledge in terms of logico-mathematical structures, and physical and social knowledge, as evidenced by changing schemas for interpreting the environment. It is the first type of knowledge, however, that is considered most important. Ausubel describes knowledge in terms of subject-matter concepts and principles. It is inferred by Ausubel, but remains unclear, that there are contingent information processing skills the child also needs to acquire.

Piaget and Ausubel also differ on interpreting cognitive changes with development. Piaget views cognitive growth as qualitative, systematic and logical changes in thought, with all information processed according to the mode of logical functioning which the individual is presently using. In contrast, Ausubel sees cognitive growth as closely related to a continuous accumulation of organized content in various subject matter areas.

Both Piaget's and Ausubel's theories consider invariant development to be the primary mechanism in intellectual functioning. As development progresses, environmental variables interact with established structures of operation, which results in an altering of intellectual structure. For Piaget, conflict resolution culminates in an equilibration of certain intellectual operations. The way the individual interacts with the environment can facilitate this process by producing changes in existing systems when they contradict reality. Ausubel hypothesizes a tendency to resolve inconsistencies through "integrative reconciliation," or the organization of information into hierarchical structures. In this sense, conflict resolution is achieved by means of reorganization of information rather than changing an intellectual process as in Piaget's model of development.

For Piaget, learning is viewed as an active process, with new knowledge constructed from within. Though Ausubel considers meaningful learning an active process, a major difference lies in the role of the learner, who, for Piaget, is constructing and reconstructing internalized ways of knowing, and, for Ausubel, is processing and restructuring the content of subject matter which exists outside the learner, which is internalized via the subsumption process. Thus, Ausubel is more concerned with concept and propositional learning, and the methods of pedagogy which best facilitate or accelerate the learning process.

A final difference between the developmental models of Piaget and Ausubel lies in their differing stage models. As previously discussed, Ausubel's stage model is a more simplistic view of stage transition, with the movement from concrete operations to formal-abstract operations stages being reflected in the individual's increasing independence from concrete props. Piaget's stage model also presents a sequence of moves from a dependency on concrete operations to abstract operations. In the first case, actions are upon objects and events (either overtly or covertly in the mind). In the latter case, actions are performed on second order concepts; that is abstractions from objects and events.

# II

## RELEVANT LITERATURE

First, a summary of concrete operational training studies and methodologies will be presented, followed by their results and related issues, such as scoring requirements, transfer, and the Genevan position of such studies. Next, a summary of advance organizer studies will be presented. Finally, the structures-of-the-whole and order of acquisition literature will be discussed, followed by a summary of the transfer literature.

### Training Studies

In the abundant short-term training studies which have attempted to induce Piagetian concrete operational skills (i.e., conservation, classification, relations, and matrices) few have employed a direct instructional method within a small group setting, such as this study used. These studies will be discussed shortly. NeoPiagetian training techniques more frequently used include: disequilibrium or cognitive conflict (Bruner, 1964, 1966; Smedslund, 1961a, 1963), identity transformation (Sheppard, 1973), addition-subtraction (Feigenbaum & Sulkin, 1964; Gruen, 1965; Hatano & Suga, 1969; Hatano, 1971; Hatano & Ito, 1966; Inagaki, 1970; Smedslund, 1961b; Smith, 1968; Wallach et al., 1967; Wallach & Sprott, 1964; Wohlwill & Lowe, 1962), language activation (Painter, 1967; Shantz & Wilson, 1971) and learning set training (Braine, 1962; Kingsley & Hall, 1967). Several studies have employed verbal feedback on simple judgment responses (Brainerd, 1972a, 1974c Bucher & Schneider, 1973; Figurelli & Keller, 1972; Overbeck & Schwartz, 1970; Siegler & Liebert, 1972) or direct demonstration (Morf, 1959; Kohnstamm, 1963; Lasry, 1966; Lasry & Laurendeau, 1969), including verbal rule instruction (Beilin, 1965).

A reasonably large body of studies have employed reversibility training (Bearison, 1969; Beilin, 1965, 1971; Brainerd & Allen, 1971; Brison, 1966; Glaser & Resnick, 1972; Goldschmid, 1968, 1971; Gruen, 1965; Hamel & Riksen, 1973; Roll, 1970; Rothenberg & Orost, 1969; Schall et al., 1972; Smith, 1968; Winer, 1968). Further methods include conformity training, using operant techniques such as modeling and tangible reinforcement (Bucher & Schneider, 1973; Denney & Acito, 1974; Henderson, Swanson, & Zimmerman, 1975; Parker, Rieff, & Sperr, 1971; Sullivan, 1967; Waghorn & Sullivan, 1970) or social interaction, including presentation by peers or "consensual decision" (Cloutier, 1973; Murray, 1973; Rosenberg & Orost, 1969; Silverman & Gerringer, 1973). A few studies have employed a task analysis approach (Caruso & Resnick, 1972; Resnick, Sigel, & Kresh, 1971) or have used discrimination training such as relevant attribute feedback and attention in learning (Gelman, 1969; Halford, 1970; Trabasso, 1968; Trabasso & Bower, 1968).

Other studies have examined the stimulus characteristics or presentation mode (Beilin, 1971; Jennings, 1960; Overton & Brodzinsky, 1972; Overton & Jordan, 1971; Parker, Rieff, & Sperr, 1971; Schwartz, 1971; Wohlwill, 1968; Wohlwill & Katz, 1967) and its significance to the subject (Kahn & Garrison, 1973). Further studies have considered the optimal developmental time for teaching concrete operational skills, including Biskin & Rice (1974) and Brainerd (1973c). Multiple training methods have also been employed in training concrete operational skills (Bingham-Newman & Hooper, 1974; Shantz & Sigel, 1967; Sigel, Roeper, & Hooper, 1966). The usual approach in multiple training methods has been to study more closely approximated normal experience than is the case in most of the other training methods previously referred to. This method has proven fairly successful, though difficult to evaluate.

The above studies were conducted primarily with a one-to-one experimenter-subject ratio, and sought to induce either single or multiple concrete operations. Results achieved were mixed, depending largely upon the age or developmental level of the Ss, the procedure used, and the type of transfer assessed. Frequently these studies favored at least one of the experimental groups over the controls. Though methodology differed, the number of studies reporting significant and enduring training effects can be viewed as indicating the possibility of enhancement or acceleration of concrete operational skills in young children. Further discussion of these results will follow a description of small group studies.

A limited number of investigations have employed small group instructional designs in teaching concrete operational skills, with varying results (Bingham-Newman & Hooper, 1974; Earhart, 1974;

Hooper, 1972; Hooper et al., 1974; Lawton, 1977; Lawton & Wanska, 1977a; Lawton et al., in preparation; Peterson, Hooper, Wanska, & DeFrain, 1975; Weikart, 1973). Such small group training studies hold both theoretical and practical appeal, responding to questions regarding the possibility of facilitation, enhancement, or acceleration of logico-mathematical knowledge, and using a small group method easily adapted to a preschool setting. Certain of these studies provide an opposite theoretical view to the Genevans, who predict that children are not likely to benefit from direct teaching of such knowledge.

A summary of the results of the training studies just referred to is presented in Table 1. The results of the various studies have been interpreted and criticized in differing ways, dependent upon the model in which the critic is working. A major difficulty in attaining a concensus of interpretations of neoPiagetian training results lies in the much-discussed criterion problem (c.f., Beilin, 1971; Braine, 1962, 1964; Brainerd, 1973a, 1973b, 1974a, 1974b, 1974d, 1977; Brainerd & Allen, 1971; Brainerd & Hooper, 1975; Gruen, 1966; Inhelder & Sinclair, 1969; Reese & Schack, 1974; Smedslund, 1963, 1965, 1969), which deals with the minimum behavioral evidence required to infer that a subject possesses a certain concrete operational skill or concept. Genevans avoid even a few false positives errors, while allowing large numbers of false negatives, in contrast to the neoGenevans who find false negative and false positive errors equally objectionable (Brainerd, 1974d).

TABLE 1

RESULTS OF CONCRETE OPERATIONAL TRAINING STUDIES*

| Skill Taught | Effects: Significant | Effects: Nonsignificant |
|---|---|---|
| Number Conservation | Beilin, 1967<br>Bucher & Schneider, 1973<br>Gruen, 1965<br>Gelman, 1969<br>Hatano & Suga, 1969<br>Rothenberg & Orost, 1969<br>Roll, 1970<br>Wallach & Sprott, 1964<br>Winer, 1968 | Wohlwill & Lowe, 1962<br>Mermelstein & Meyer, 1969 |
| Length Conservation | Beilin, 1965<br>Brainerd, 1974(c)<br>Bucher & Schneider, 1973<br>Gelman, 1969<br>Gruen, 1965<br>Kingsley & Hall, 1967<br>Murray, 1968 | Smedslund, 1963 |
| Quantity & Substance Conservation | Brainerd, 1972(a)<br>Brison, 1966<br>Bucher & Schneider, 1973<br>Curcio et al., 1972<br>Hamel & Riksen, 1973<br>Miller et al., 1975<br>Inhelder et al., 1974 | Fleischmann et al., 1966 |
| Weight Conservation | Brainerd, 1973; 1974<br>Kingsley & Hall, 1967<br>Smith, 1968 | Smedslund, 1961b, 1961c |
| Relations (Seriation) | Bingham-Newman & Hooper, 1974<br>Burke-Merkle & Hooper, 1973<br>Henderson et al., 1975<br>Hooper, 1972 | |
| Class Inclusion | Brainerd, 1973 | |
| Transitivity | Mouw & Hecht, 1973 | |

*This table is not exhaustive, but presents a sampling of relevant studies.

A related issue concerns the stringent judgments-plus-explanations requirement made by the Genevans. Under this condition, a subject must make the correct response, explain why, and even resist counter-suggestions. Brainerd (1973b, 1974d) puts forth the argument that the judgments-plus-explanations criterion does not appear to follow from Piagetian theory, and that a theoretical rationale for it cannot be constructed. Brainerd further states (1974d) that the methodological rationales for the criterion used by Smedslund (1963, 1969) and other Genevans are non sequiturs. Brainerd cites the lack of correlation between success in training and stringency of criteria, pointing out that "the relationship is about zero" (Brainerd & Allen, 1971).

A further difference in the interpretation of concrete operations training data concerns the amount of far transfer. The Genevans have criticized training studies as skill-specific, and not true evidence that the concrete operational stage can be facilitated or accelerated. Again, the structures-of-the-whole stage concept is a source of disagreement between neoGenevan and Genevan theorists and researchers. This matter will be further discussed in the transfer literature review section.

The staunch Genevan position on training has changed somewhat over the past two and a half decades, as evidenced, for example, by Flavell's changing opinion of training studies. Flavell's revised position states, "The early Piagetian training studies had negative outcomes, but the picture is now changing. If our reading of recent trends is correct, few on either side of the Atlantic would now maintain that one cannot by any pedagogic means measurably spur, solidify, or otherwise further the child's concrete-operational progress" (Flavell & Hill, 1969, p. 19).

The role of environmental factors and facilitation of concrete operational skills is also gaining more attention in the recent Genevan literature. In a volume of recent experiments in learning and cognitive development, Inhelder, Sinclair, and Bovet contend, "Work on learning is not only compatible with developmental psychology, but it may help to overcome some of the difficulties encountered in cognitive learning theories" (1974, p. 24). They further state, "We started with the idea that under certain conditions an acceleration of cognitive development would be possible... (this), in terms of successful training procedures, (interaction theory) means that the more active a subject is, the more successful this learning is likely to be." They qualify this with, "(the subject) may be cognitively active without manipulating a given type of material" (ibid., p. 25).

Thus, even in the most stringent Genevan schools of cognitive research, the evidence of facilitation and better understanding of concrete operational abilities through the use of training methodologies such as those described in this section is gaining support. The question of the most effective and developmentally appropriate method of facilitation remains unresolved.

Advance Organizer Studies

Much of the earlier advance organizer research (e.g., Ausubel, 1960, 1961; Ausubel & Fitzgerald, 1961, 1962; Ausubel & Youssef, 1963; Groteluescher & Sjogren, 1968; Neisworth, 1967; Schultz, 1966; Woodward, 1966) is of limited relevance to this study for several reasons. Subjects were typically high school or college students, and in some cases were not pretested in the areas taught (i.e., for existing subsumers). Most of these earlier studies lacked consistent and clear definitions of an advance organizer, weakening comparisons between experimental and control groups, and potentially confounding the results. Length of treatments also varied greatly.

The lack of agreement on an operational definition of advance organizer, previously discussed, creates major problems in assessing the facilitory effects of AOs on different age groups and in various subject matter areas. However, this review will include a brief summary of major results.

In their review, Hartley and Davies (1976) comment that fifteen years of advance organizer research provides "confused results." Although in the majority of AO studies organizers appear to facilitate learning and retention, a number of major differences in results deserve comment. In certain cases, organizers appear to be specific rather than general (Earle, 1971; Projer et al., 1970). Hartley and Davies (ibid) point out that some individuals, such as college students and above average school children, appear to benefit from organizers more than others. However, some researchers contend that expository organizers may be "most useful with children who have low verbal and analytical ability" (Ausubel & Fitzgerald, 1962; Schultz, 1966).

Relatively few studies have employed advance organizers with primary children (i.e., grades one through six), and even fewer have presented AOs to preschool children. These limited studies have produced contradictory results concerning the efficacy of AOs as a teaching strategy with young children. Studies reporting significant advance organizer effects for grade-school children include: Lawton (1977a, 1977b, 1977c), Lawton and Wanska (1977), Lawton et al. (in preparation), Neisworth (1968), Steinbrink (1970), and Weisberg (1970). These studies also varied in subject matter taught, with Neisworth (1968) and Weisberg (1970) employing AOs in teaching science concepts, Steinbrink (1970) and Lawton (1977a) teaching social studies, Lawton (1977b) teaching science, and Lawton and Wanska (1976, 1977a, 1977b) comparing process (hierarchical classification) and content (social studies) areas. The only studies employing AOs with preschool or kindergarten children were Lawton 1977a), Lawton and Fowell (1977), Lawton, Stampfl, & Moschis (1977), Lawton and Wanska (1977) and Lawton, Hooper, Saunders, and Roth (in preparation). In the latter two studies, AO lessons presented both process and content concepts.

Advance organizer studies with school-age children which did not yield significant results include Schultz (1966), with the teaching of science content, Clawson and Barnes (1973), and Moore, Barnes, and Barnes (1975), with the teaching of social studies and anthropology.

This can be accounted for, at least in part, by a lack of consistency in design, particularly in the areas of pretesting and control treatment, and the varying interpretations of the construction and use of advance organizers. However, it is true to say that the weight of evidence supports the facilitative effects of this type of instruction. What is required is a clarification of information processing techniques that may be used in learning high-order ideas or principles; the adaptability of expository instruction, especially in cases where errors in learning occurs; and distinctions between the structure of content and that of process.

As Lawton and Wanska (1977a) state, "It seems clear that more definitive and stringent tests of the structure of AOs are needed... with more attention given to determining the viability of teaching logical operational thinking."

Structures-of-the-Whole Literature

The second area of interest in the present study concerns the Genevan assumption of the synchrony of acquisition of logical operations, or structures-of-the-whole previously discussed. Piaget (1960, 1964) hypothesizes that seriation and class inclusion develop synchronously, and makes further claims which yield two predicted orders of skill emergence: (1) class inclusion < > seriation (i.e., synchronous development) < transitivity < conservation, and (2) conservation < class inclusion < transitivity. Smedslund (1964) states that class inclusion precedes seriation. Yet Piaget (1952) states that conservation is a necessary precondition for seriation.

NeoPiagetian researchers (e.g., Brainerd, 1973c; Hooper et al., 1974; Lovell, Mitchell, & Everett, 1962; Smedslund, 1964) employing longitudinal or cross-sectional designs have generally found asynchronous skill development, with differing orders of emergence. Kofsky (1966) employed a scalagram analysis with 40 6-to-9-year-old children and found six levels of difficulty in children's classificatory abilities, ranging from sorting by resemblance, which was easiest, through multiple classification and class inclusion, to hierarchical classification, which was most difficult.

Hooper et al. (1974) employed another cross-sectional scaling analysis of preschool through 4th and 5th grade children's concrete operational classificatory abilities, yielding the following order of difficulty: free sorting < double series matrix reproduction < cross classification matrix transposition < "some-all" understanding < double series transposition < producing three exhaustive sorts < class inclusion understanding < combinatorial reasoning. This study concludes that the child's understanding of class inclusion relationships evolves gradually, contingent on previous mastery of less complex classificatory skills.

Brainerd (1973c) cites findings from two studies which were inconsistent with both Piagetian theory and previous results. First, transitivity emerged before both conservation and class inclusion, and second, conservation was found to emerge before class inclusion. Brainerd's results consistently showed class inclusion emerging later than either transitivity or conservation, and gave evidence for earlier age of skill acquisition than predicted by Piagetian theory, with over half the 5-to-6-year-olds possessing transitivity. The later appearance of class inclusion was a result which was supported by the Hooper et al. (1974) study, cited above.

Fenker and Tees (1976) argue that the demand characteristics of sorting tasks make them unreliable techniques for assessing cognitive structures in children, as compared to similarity tasks. They employed a multidimensional scaling analysis of cognitive structures in 5-year-olds, comparing performance on classificatory sorting and similarity-estimating tasks. Their results show that 92% of the Ss had organized structures for similarity estimation, while only 30% had stable sorting structures. Thus, the tasks used in evaluating the order of skill acquisition in young children may yield distorted evidence.

The measurement techniques of previous neoPiagetian order-of-emergence studies has met with several other criticisms (c.f., Beilin, 1970; Brainerd, 1973b; Brainerd & Allen, 1971; Hooper et al., 1971). Brainerd (1973b) lists the following criticisms: (1) the consistent failure to equate the relative sensitivities of the assessment devices, which could both mask sequences and show sequences where none existed (c.f., Flavell, 1972), and (2) lack of agreement on whether correct responses alone versus correct judgments plus explanations demonstrate the presence or absence of a given skill, with explanations subject to at least two sources of Type II errors, which judgments are not.

Brainerd (1973b) further discusses the possibility that the order observed at one age may be peculiar to that age or level, concluding that for older Ss, such as his second grade subjects, transitivity and conservation were of equal difficulty, while younger Ss found conservation more difficult. At all three age levels Brainerd examined, transitivity and conservation emerged sooner than class inclusion. Brainerd cites Braine's (1964) argument that the median age for transitivity is 5-6 years, while the Genevans contend it is 7-8. The results of Brainerd's study support Braine's claim.

Flavell (1971) proposed a classification system for cognitive-developmental sequences which described a formal or causal relationship between an earlier-developing cognitive skill and a later-developing skill as one of the following: addition, substitution, modification, inclusion, or mediation.

Brainerd (1975, p. 372) points out that of the eight structures defining the concrete-operational stage, four are concerned with the elementary logic of relations and four with classes, providing a potential "relational dimension" and a "classification dimension."

Brainerd interprets Bingham-Newman and Hooper's (1974) previously mentioned conclusions and further training results to infer that children make much progress on the relational dimension before they make any progress on the classificatory dimension.

Transfer of Training Studies

Closely related to the structures-of-the-whole issue, the predictions made by the Genevans and neoPiagetian learning theorists differ regarding the degree and type of transfer which will follow "successful" training of a Piagetian operation. Posttests in most training studies have generally measured either specific transfer, which may also be divided into "near-near" and "near-far" transfer, and nonspecific or "far-far" transfer (c.f., Brainerd, 1975). As previously discussed, far-far transfer is unique to the structures-of-the-whole position taken by the Genevans, with nonspecific transfer predicted on the basis of common structures (Beilin, 1971). This assumption is based in part on Piaget's earlier contention (1964) that truly successful training or enhancement can withstand the tests of generalization to other novel same-stage operations in addition to enduring over time, and not merely accelerating already present cognitive structures. If training experiences succeed in facilitating "true" structural alterations, significant transfer to the logically related concept domains should also be evident (Hooper et al., 1974). The Genevans still contend that specific training experiences do not induce operations, but accelerate logical structures already present (Hooper et al., 1974; Inhelder &

Sinclair, 1969; Klausmeier & Hooper, 1974; Kuhn, 1974; Strauss, 1972). Whether or not logical operations can be initiated by training, the weight of successful training results indicates that some logical concepts and related task performance can be enhanced.

Some potential internal inconsistencies in Piagetian theory and transfer positions have been discussed (Beilin, 1971; Brainerd, 1974d). They point out the possible contradiction of horizontal decalage and transfer via common structure (near-far and far transfer). Beilin (1971, p. 78) points out that one problem with the common factor versus decalage conflict is its complication of the interpretation of "stage," which is defined both by common structure and vertical decalage. Further problems arise when horizontal and "oblique" decalages merge into the vertical decalages.

Inhelder states that:

> Learning experiments may provide a satisfactory method of analyzing the reasons for decalages, since the presentation of situations that highlight the similarities between the various conservation concepts can lead to the observation of conflicts between the child's organizing activity and his incapacity to adapt this activity to particular objects. Concepts . . . are in constant interaction with each other . . . it is preferable to think of (transfer) in terms of the extention of fields of operativity; and this implies a careful analysis of the differences and similarities between the various types of cognitive constructs. (Inhelder et al., 1974, p. 15)

Few of the concrete operational training studies have employed posttest tasks which assess the theoretically crucial nonspecific transfer, and those which have measured nonspecific transfer report differing results. Brainerd (1974c) trained preschool children, using verbal feedback, to acquire transitive inference, conservation, and class inclusion of length. He found little interconcept transfer (i.e., across concept comparisons, or nonspecific transfer), while intraconcept transfer (i.e., specific, from length to weight content) was significant for all training conditions.

Hooper et al. (1974) employed a different teaching procedure to assess instructional transfer effects of small group sessions on transitive inference, conservation, and class inclusion of length, with differing results from the Brainerd (1974c) study. No intraconcept, or specific transfer to weight concepts were shown, while there was some evidence for interconcept (i.e., nonspecific) transfer for conservation and transitivity concepts and to the logical groupement performances.

Burke-Merkle and Hooper (1973) also employed a small group instructional program in a transfer of training design in classificatory, seriation, and combined classification/seriation skills. Significant specific transfer effects were found for the seriation instructional condition, while few differences were found for classification, verbal intelligence, or far transfer conservation measures. These results are similar to Hooper's (1972) results in terms of specific transfer and seriation instruction effects. Two similar studies using classificatory instructional methods reported a lack of specific, or near-near transfer (Shantz & Sigel, 1967; Sigel & Olmstead, 1970). Sigel and Olmstead (ibid) also did not find far-far transfer to conservation tasks with 5-to-6-year-olds.

In contrast to the Sigel and Olmstead results on far transfer, Shantz and Sigel (1967) and Sigel, Roeper, and Hooper (1966) reported far transfer to conservation skills using older Ss (i.e., in terms of mental age) than the subsequent Sigel study.

Recent Genevan studies on transfer have demonstrated nonspecific transfer of training from one-to-one correspondence to conservation of quantity (i.e., liquids and clay) by both Ss who were nonconservers on the pretests and those termed "intermediate" (i.e., transitional), with the intermediates showing longer retention and even improvement on delayed posttests (Inhelder, Sinclair, & Bovet, 1974, p. 66). Another transfer of training study reported by Inhelder et al. involved four levels of Ss (in terms of pretest conservation scores) who were trained on numerical equality, using small pieces of clay, which were used both in one-to-one correspondence and stuck together during training sessions. The Ss scoring highest on number and continuous matter conservation pretests (but who had not been consistent conservers prior to training) showed stable transfer to these tasks on all posttests and delayed posts. Some Ss from the lower levels showed transfer to conservation posttests, using materials not employed in the training sessions (1974, p. 88).

A third experiment by Inhelder et al. trained Ss in class inclusion, with pre- and post- and delayed posttests over conservation of matter (i.e., clay) and liquid pouring and conservation. Although none of the Ss trained had shown consistent conservation on the pretests, several Ss attained it on the posttests, with the higher scoring Ss showing greater retention and more logical explanations of their conserving responses on the delayed posttests (1974, p. 200). These results appear to show that nonspecific (near-far and far-far) transfer is best facilitated in Ss whose pretest responses are transitional, a result differing from Brainerd's (1974c) results. However, due to the small number of Ss and the radically different scoring criteria and training methodology, it is hard to compare such results.

In summary, a large number of training studies of both Piagetian and Ausubelian orientation have demonstrated specific transfer (sequential transfer) of training, while a small number of studies have shown non-specific transfer. Piagetian type studies generally ignore the effect of content and task complexity on learning, or report such effects as post-hoc observations. Studies using advance organizer instruction have mainly concentrated on content structure and ignored the structure of information processing. Although the concept of structures-of-the-whole has been seriously questioned, further research is required to further tease out the transfer factor inherent in this problem. Finally, it appears profitable to further examine advance organizer type and structure and related teaching methodologies.

## III

## DESIGN AND METHOD

### Design

This experiment used a pretest-training-posttest-transfer task test design. The pretests were used to establish a sample of 4-5-year-old children, naive in the use of concrete operations (classification, relations, and conservation). Posttests were delayed (administered 6 weeks following training) to measure the power of the training technique. The posttests were immediately followed by transfer/task tests. The experimental design is represented in Table 2.

A multiple measures factorial design was employed to evaluate effects of two methods of advance organizer presentation on preschool children's learning of hierarchical classification and relations. A related objective was to measure the generalizability and stability of such learning. The two forms of advance organizer (AO) used were expository (EO) and guided self-discovery (GSDO). The test battery consisted of classification, relations, and conservation tasks, and problem-solving tasks which required the application of classification and seriation skills. Children performing at the level of concrete operations, as measured by the eight pretests, were eliminated. Ss initially failing the pretest tasks were allocated to one of five treatment groups by a process of

TABLE 2

EXPERIMENTAL DESIGN

| Treatment Groups | N | $T_1$* Pretests** | Presentation Mode (of AO lesson) at 4 weeks | $T_2$ Posttests | $T_3$ Transfer Tasks*** |
|---|---|---|---|---|---|
| HC[a] | 9 | * | EO[c] | at 10 weeks | at 14 weeks |
| | 9 | * | GSDO[d] | at 10 weeks | at 14 weeks |
| R[b] | 9 | * | EO | at 10 weeks | at 14 weeks |
| | 9 | * | GSDO | at 10 weeks | at 14 weeks |
| C[e] | 9 | * | No AO | at 10 weeks | at 14 weeks |

*$T_1$ : Pretests were given before treatment group assignments were made.

[a]HC : Hierarchical Classification

[b]R : Relations

[c]EO : Expository Organizer

[d]GSDO: Guided Self-discovery Organizer

[e]C : Control

**Pre and Posttests : Spontaneous Classification, Tasks 1 & 2; Class Inclusion, Tasks 1 & 2; Additive Seriation, Tasks 1 & 2; One-to-One Correspondence Seriation, Tasks 1 & 2

***Transfer Tasks : Cross Classification 3 x 3 Matrix
Cross Seriation 3 x 3 Matrix
Classification Problem-solving Task
Seriation Problem-solving Task
Conservation of Area
Conservation of Number

stratified assignment. Each group subsequently received three teaching sessions, eight posttests, and six transfer task tests.

Sample

Initially, the pretests were given to 56 children selected randomly from three preschools in Madison, Wisconsin. Each of the pretests had a score range of 0-2, based on a percentage conversion of the raw scores. A pass score of 2 points per task was established. Any child passing on two or more of the eight pretest tasks was judged to be at Stage III of concrete operations (c.f., Brainerd, 1976; Beilin, 1965), and was excluded from the study. As a result of applying this criteria, 45 Ss remained from the original sample.

A stratified assignment technique was used to assign the 45 children remaining from the original sample to five treatment groups. By assigning Ss to groups by their pretest scores, each of the experimental groups was matched for mean pretest score and range. This resulted in there being nine subjects per treatment group.

For the pre, post, and transfer tests the children were tested individually. For the pre and posttests, each child received 4 classification and 4 relations tasks. There was a maximum score of 2 points for each task. All teaching was done with small groups of either four or five children. Teaching of the experimental groups was done by the author, and teaching of the control groups by their teachers, who were unaware of the research design. The teachers were instructed to use the materials as they normally would in their classrooms, with an effort made by the author to equate the control conditions (i.e., presentation styles of the two teachers).

Subjects

Subjects were 45 children from three Madison, Wisconsin pre-schools. These Ss were placed in five treatment groups by stratified assignment. Mean age for the sample at the beginning of the investigation was 54.5 months, with a range of 45-63 months. Mean ages for the five treatment groups were as follows: group 1 (ER/R), 53.4 months (range: 46-61); group 2 (EO/HC), 50.5 months (range: 47-57); group 3 (GSDO/R), 55.5 months (range: 46-63); group 4 (GSDO/HC), 51.8 months (range: 47-58); group 5 (C), 55.1 months (range: 49-63). Treatment group characteristics are provided in Table 3.

Testing Materials

Materials for the pre and posttests were as follows:

Spontaneous Multiple Classification - (1) three small plastic triangles, red, yellow, and blue; three small circles, red, yellow, and blue; three large triangles, red, yellow, and blue. (2) nine 3" by 4" laminated cards with pictures of dogs as follows: sitting, standing on four legs, or standing on three legs, and with tongues in or out. In each case, these materials could be exhaustively sorted by at least three criteria.

## TABLE 3

### TREATMENT GROUP CHARACTERISTICS

| Experimental Condition | N | Mean Age (in months) | Age Range | Females | Males | Mean Total Pretest Score* |
|---|---|---|---|---|---|---|
| Expository/ Classification | 9 | 50.5 | 47 - 57 | 3 | 6 | 3.22 |
| Expository/ Relations | 9 | 53.4 | 46 - 61 | 3 | 6 | 3.66 |
| Guided Self-Discovery/ Classification | 9 | 51.8 | 47 - 58 | 3 | 6 | 3.55 |
| Guided Self-Discovery/ Relations | 9 | 55.5 | 46 - 63 | 1 | 8 | 3.77 |
| Control | 9 | 55.1 | 49 - 61 | 6 | 3 | 3.77 |

*Total possible score = 16

Class Inclusion - (1) cut-out figures of two adult females (8-1/4" tall), three girls (4-3/4" tall), and five boys (4-3/4" tall); (2) construction paper cut-out shapes of six black dogs (6-3/4" nose-to-tail by 4" nose-to-front paws), five yellow birds (6-3/4" beak-to-tail by 5-1/4" wingspan), and four gray cats (4-1/4" nose-to-tail by 4-3/4" tall).

Additive Seriation - (1) seven cut-out (and colored) orange fish of increasing size (from 2", smallest, to 8", largest); (2) seven clear plastic tumblers of equal size, containing colored water (from a tumbler with 2 tablespoons of colored water, least amount, to one with 14 tablespoons, greatest amount).

Seriation: One-to-One Correspondence - (1) seven orange fish, varying in size from smallest (2") to largest (8"), and seven cut-out brown worms, varying in size from shortest (1-1/2") to longest (7-1/2"); (2) seven firemen, varying in width from thinnest (1" across at waist) to fattest (4-1/2"), and seven ladders, varying in width from narrowest (1") to widest (5-1/2").

Materials for the transfer tasks were as follows:

Cross-classification - one 9" by 9" matrix board; nine 2-3/4" tall cut-out shapes: three diamonds, three hearts, and three "X"s (one of each shape was yellow, one was red, and one was green).

Cross-seriation - one 9" by 9" matrix board; nine cut-out evergreen trees in three sizes, 1", 1-1/2", and 2" tall (one of each size was green yellow, one was yellow green, and one was green).

Seriation Problem Solving Task - five white cut-out "snow-people" whose heights varied from tallest (5-1/4") to shortest (1-1/4"), and five blue, yellow, green, and red hats (2 of which were blue), which varied in size from largest (2-1/2" tall) to smallest (3/4").

Classification Problem Solving Task - twelve picture cards (2" by 4") of four kinds of "zoo animals," as follows: two turtles, three snakes, three small rodents, and four birds, and twelve green plastic pint fruit containers, referred to as "cages."

Conservation of Area - two identical green cardboard "fields" (10-1/2" by 7-1/2") and six identical sized red ladybugs with black spots and antennae (5" long by 3" in widest part).

Conservation of Number - twelve pennies.

Complete test protocols are provided in Appendix A.

Testing Procedure

For all pretests, posttests, and transfer tasks children were tested individually. Testing sessions were conducted in a room adjoining the preschool classroom, with the tester and S sitting on the floor across from each other. Only one task was administered each testing session. The order in which the pre and post classification tasks were administered is listed in Table 4.

Testers were 12 female students in the Early Childhood Education Program at the University of Wisconsin, and were trained by the experimenter. Each tester gave either the series of classification or the series of relations pre, post, and transfer tests. Each task

TABLE 4

ORDER OF ADMINISTRATION OF ALL TESTS*

| Relations Pre and Posttests | Classification Pre and Posttests |
|---|---|
| Additive seriation - task 1<br>Additive seriation - task 2<br>One-to-One correspondence Seriation - task 1<br>One-to-One correspondence Seriation - task 2 | Spontaneous classification - task 1<br>Spontaneous classification - task 2<br>Class inculsion - task 1<br>Class inclusion - task 2 |
| **Relations Transfer Tests** | **Classification Transfer Tests** |
| Cross seriation 3 x 3 matrix<br>One-to-One correspondence Problem-solving task | Cross classification 3 x 3 matrix<br>Spontaneous classification Problem-solving task |

Conservation Transfer Tests

Conservation of area: identity
Conservation of area: equivalence
Conservation of number: equivalence.

*Testers administered either the series of relations or classification tests, so that Ss were being tested in both areas at approximately the same time during the testing periods. Conservation tests were administered last, and divided between the testers.

took about ten minutes to administer.

Scoring

For each task a three point scale: 0, 1, 2 was used to score responses in the same way as previously used by Beilin (1965) and Brainerd (1977), and corresponding to the stages identified by Piaget. According to Piaget (1952, 1970), Stage I performance corresponds to the intuitive preoperational stage (score = 0), Stage II, the transition between pre- and concrete operations (score = 1), and Stage III, concrete operations (score = 2). Stage I is characterized by, for example, consistent nonconservation or non-classification, Stage II, by intermediate reactions, such as inconsistent conserving or classificatory responses (c.f., Larson & Flavell, 1971), or changing a conserving prediction to a nonconserving assessment after the deformation (Brainerd & Brainerd, 1976), and Stage III, by consistent conservation of quantitative relationships and hierarchical classification.

Beilin (1965), who initially examined the relationship between stage and conservation learning, used test performance to assign stages. Subjects passing both number and length tests were classified Stage III, Ss passing one but not both, Stage II, and those passing neither, Stage I. This was modified somewhat by later researchers, including Strauss and Langer (1970), who used as stage criteria Stage III - all tests passed, Stage II - one test passed, and Stage I - no tests passed. Strauss and Rimalt (1974) used still different criteria. A Stage III designation in this case required 3/3 items passed (on a given part of a test), Stage II, 1/3 or 2/3 items passed, and Stage I, 0/3 items passed.

Initial raw scores were converted to 0, 1, or 2 according to percentage correct on each task. For each task, 25% or less correct responses were assigned the score 0, 26-74% correct were assigned the score 1, and 75-100% correct were scored 2.

Since it has been shown that a judgments-plus-explanations criterion for passing Piagetian tasks tends to mask true developmental sequences and leads to two potential sources of Type II error (e.g., Brainerd, 1973, 1974, 1977; Brainerd & Hooper, 1975), a judgments-only scoring criterion was used for all pretest, posttest, and transfer tasks, with the exception of class inclusion. Both a correct judgment and an adequate explanation were required to receive a score of 2 on the class inclusion pre and posttests, with the subject required to indicate comprehension of the subordinate/superordinate class relationship (e.g., "There are more people because boys are people," etc.). This stricter criterion was used to decrease the probability of scoring a response "correct" when it was given for the wrong reason, such as statement of a false positive due to the child being forced to choose between A/B (the sub- and superordinate classes) when he is actually responding in terms of A/A' (the two subordinate classes). This may lead to a random guess, which would be correct a portion of the time, even though the child did not understand the class inclusion inference (c.f., Brainerd & Kaszor, 1974).

A description of correct performance and total number of possible correct responses for each task in the pre and posttest battery now follows.

<u>One-to-One Correspondence Seriation</u>, tasks 1 and 2 - A correct placement of worms (task 1) or ladders (task 2) in one-to-one correspondence was required for a response to be scored correct. Total number of possible responses was twelve.

<u>Additive Seriation</u>, tasks 1 and 2 - A correct placement of <u>one</u> additional stick in a previously seriated row (tasks 1 and 2) and either <u>three</u> additional fish (task 1) or <u>three</u> additional tumblers (task 2) in a previously seriated row was required to be scored correct. Total number of possible responses was four.

<u>Spontaneous Classification</u>, tasks 1 and 2 - These tasks were scored by three criteria. First, three exhaustive sorts of each set of materials (for either task 1 or task 2) were required, with a total possible score of 8 points. Second, each sub-group of the three possible groupings for each set of materials required a verbal label (e.g., "red, yellow, blue," etc.), with a total possible score of 8 points. Third, an appropriate reason for constructing correctly identified subgroups (e.g., "they're the same shape, color," etc.) was required for an additional point on each section of the tasks, with the total possible score for this criterion being 3. The overall total of possible correct responses for either task 1 or task 2 was 19.

Class Inclusion, tasks 1 and 2 - Each child was asked five class inclusion questions (e.g., "Are there more dogs or more animals?"), five check questions (e.g., "When you say there are more dogs, which are the dogs and which are the animals?"), and five justification questions (e.g., "Can you explain why there are more animals than dogs?"). The total number of possible correct responses for either task 1 or task 2 was 15.

Cross-classification and Cross-seriation - These tasks were given 2 points if completed correctly (i.e., with all nine objects placed correctly on the matrix board), 1 point if either three of the vertical or three of the horizontal rows were correctly classified or seriated (but not both), and 0 points if less than three series were correctly classified or seriated, including all partial or random arrangements. Strategies used by Ss in these tasks were noted by the testers, but were not included in the scoring or analyses.

Classification Problem - The classification problem was scored on two responses: (1) making the necessary groupings (e.g., sorting animals into appropriate sub-classes) and (2) answering the question, "How many cages do you need in your zoo if you put only animals which are alike together?", which had been introduced in story form, with two possible correct responses.

Seriation Problem: One-to-One Correspondence - The seriation problem had three questions (e.g., "Which hat belongs to this snow-person?"). Each question, in order to be answered correctly required the child to use an appropriate seriation strategy. There were four responses, one correct seriation (in one-to-one correspondence) of the hats and snowpeople, and three questions regarding a correspondence relationship.

Conservation of Area and Number. - All the conservation tasks were scored either pass or fail, with Ss required to get at least 75% of the possible responses correct to be scored a pass (i.e., a score of 2). A judgment-only criterion was applied to the scoring procedure. Conservation of area was divided into three identity questions and six equivalence questions. Identity and equivalence tasks were scored as separate tasks (i.e., there were nine possible conservation of area sub-tasks). Conservation of number consisted of two equivalence sections (i.e., expansion of a row of pennies and pennies in a heap), with a total of six possible correct responses.

## Teaching Materials

Materials for the teaching sessions are described below. For each skill area there was one set of materials. The same set of materials was used for each treatment group taught the skill that set was used in conjunction with. Thus, materials remained constant, though teaching methods changed.

Relations. - Relations instructional materials consisted of: five sticks, ranging from shortest (2") to longest (6"); seven umbrellas of increasing heights and widths; four metal weights (ranging from 100 to 500 grams); six identical baby food jars, containing increasing amounts of potting soil; five measuring cups; two sets of wooden cylinder clocks (with 4 and 8 blocks per set) of increasing width and height; three cut-out paper apples and five stems of increasing size; three bears, three sets of clothes, three bowls, three spoons, three chairs, and three beds, all constructed on a scale from largest to smallest; seven cut-out witches, seven hats, seven brooms, and seven cats, of increasing size; three sets of butterfly cards, with three 3" by 3" cards per set, in increasingly darker shades of blue, pink, and black, respectively; one set of five cards with dots in various colors, with the number of dots ranging from 1 to 5.

Hierarchical Classification

Hierarchical classification instructional materials consisted of: one tape measure; two small paper cups containing two teaspoons of flour and two teaspoons of sugar, respectively; two yellow plastic bowls, two plates, and two cups; twelve wooden cube blocks, three red blocks, three yellow blocks, and three green blocks; four plastic capped film cannisters, two containing paper clips and two containing beans; six cards with 1, 2, or 3 dots in red, yellow, and blue; twenty (1" tall) plastic teddy bears, with five blue bears, five red bears, five green bears, and five yellow bears; twenty plastic mice (2" long) in the same colors as the bears; sets (in plastic lunch bags) of 12 miniature marshmallows, with four yellow, three pink, three green, and two orange marshmallows per set;

sixteen (2-1/2" square) cards with pictures of four pets, five kinds of food, three things to wear, and four toys; sets of 13 M&M candies with four black, three red, four yellow, and two green M&M candies per set.

Inter-rater Reliability Measures

Before the teaching procedures began, scripts of each type of lesson were given to four raters for evaluation, to insure that genuine differences in the initial organization of lesson format and intended mode of presentation method existed (see Appendix B). The raters were a preschool teacher, a University preschool supervising-teacher, a graduate student in Child Development, and a Professor in Child and Family Studies, none of whom was aware of the research design. They were instructed to evaluate the lesson scripts according to the following criteria: a) amount of teacher direction, b) type of teacher statements, and c) overall similarities and differences between lessons. Raters completed a rating sheet which used a 1-5 scale, ranging from: a) "no direction" to "entirely teacher directed," b) "no factual statements" to "all factual statements," and c) "no difference" to "entirely different" (see Appendix B).

In order to obtain an estimate of reliability, the results of this evaluation were submitted to a Kuder-Richardson formula 20, which yielded an $r$ of .85. Also, during the study, one 25 minute session of each type of teaching procedure (AO) was transcribed from a tape recording. These transcripts were given to the same four raters for evaluation. The Kuder-Richardson formula 20 yielded a reliability coefficient of .89. It can be assumed, therefore, that both the intention and practice of both types of teaching procedure were sufficiently discriminated.

Teaching Procedure

Teaching sessions for all children were conducted in small groups of four or five children in rooms adjoining the preschool classrooms. The children in control groups were taught by their regular teacher. Each treatment group received three related instructional sessions (i.e., AO lessons) during a two week period, beginning two weeks after pretesting was completed. All instructional sessions were tape recorded for inter-rater reliability measures. Transcripts of each type of AO lesson are included in Appendix B. A general description of each type of AO lesson is presented here.

The teaching format for the two treatment groups (i.e., expository and guided self-discovery) differed in presentation method. For both expository and guided self-discovery organizer lessons, concepts and principles were presented at a relatively high level of generality and abstractness. Straightforward statements were made in EO lessons and questions used in the GSDO lessons. Before progressing to the next statement or question in a given organizer sequence, E attempted to evaluate the understanding of the superordinate concepts already presented. Thus, each session following the first began with a review of previous material. This procedure was used in an attempt to accentuate the meaningful relationship of previously learned material to that which was subsequently presented. Formative assessment was used to pace the progression of the AO sequences. A sample of the assessment measures is found in Appendix B.

During the expository AO lessons, children were presented hierarchically sequenced learning materials. The first lesson was introduced by referring the children to familiar objects in the room and identifying their properties with very general statements. This was done in an attempt to relate present learning to existing subsumers and make use of familiar concrete objects in introducing general ideas about properties or measurement. The teacher adopted a story-telling narrative to express general ideas about the hierarchical organization of learning materials. For example, the children in classification groups were told that there were many things or objects in the world and that these things had properties which could be identified in some way. Similarly, children in relations groups were told that things had properties which could be measured. The children were then provided with ways of measuring the properties of objects (e.g., measuring tape to identify or measure the property of length, scales to identify or measure the property of weight, food stuffs of varying tastes, and so on) and were told that certain things shared properties which can be identified or measured. The expository relations AO lessons placed emphasis on the different amounts of some measurable property (e.g., differing heights, weights, colors, etc.).

These objects were used to demonstrate general concepts and relationships presented by the teacher. At this time, children actively manipulated objects (i.e., classified or seriated) under the direction of the teacher. At all times during the expository organizer an attempt was made by the teacher where relevant to relate new concepts or examples to related concepts previously discussed or introduced by the children. In other words, the teacher attempted to take advantage of the relevant subsumers which the children appeared to have in cognitive structure at the outset of the training experience or which they acquired as instruction progressed.

Organizer lessons for the guided self-discovery groups consisted of asking hierarchically sequenced questions which were intended to encourage Ss to discover (a) properties of objects, and (b) relationships between and among objects. Factual statements were avoided by E. Questions were related to the same concrete materials as used with expository groups, and in the same sequence. The guided self-discovery classification organizers began with questions such as, "What can you see in this room? What can we know about these things? How can you find out or know these things? Can you see any things which are alike in some way?" As in the expository instructional sequence, E attempted to begin with questions which would have a meaningful relationship to concepts already in the learner's cognitive structure, and which would become more specific as the sequence of materials and questions pertaining to these materials and ideas progressed. By asking questions, E attempted to gauge the speed at which the learning experiences should progress. The same formative assessments used for the expository groups (see Appendix B) were also used for the guided self-discovery groups. Both expository and guided self-discovery lessons took 25 minutes each.

Control Condition

In the case of Control groups, lessons were taught by regular teachers in two of the preschools from which the sample was drawn. These teachers were unaware of the objectives of the study reported here. The teachers were shown the instructional materials used with the experimental treatment groups and were asked, (1) "Would you use such materials in your classroom?" and (2) "If so, how would they be used with a small group of children during a 25 minute session?" The various responses obtained from teachers were compared. It was found that responses did not differ from each other to any large extent. A number of suggestions for the use of materials were drawn up and provided to each teacher. The control group lessons consisted of the teacher sitting at a table or on the floor with the materials displayed, and encouraging the children to examine and play with all the objects. Teachers asked questions such as "What do you call this . . .?" and made statements such as "See how many things you can do with these . . ." It was determined by questionnaire that no particular sequence of statements or questions were followed. The general nature of these lessons seemed to approximate the description of introductory type lessons as described by Ausubel (e.g., 1968). Such lessons are not expected to result in the same degree of meaningful learning and retention as AO lessons.

Control sessions took place at the same time of day, and lasted the same length of time (i.e., 25 minutes) as experimental sessions. There were either four or five Ss in each control group.

Major Hypotheses

The major hypotheses in this study predict the following results:

1. Performance by groups receiving AO instruction will be significantly better than that of controls.

2. Performance on classification and seriation tasks will be improved by AO instruction.

3. Performance on classification posttests will be most affected by hierarchical classification AO instruction, and performance on seriation posttests will be most affected by relations AO instructions.

4. Performance of groups taught by expository organizers (EOs) will be superior to that of groups taught by guided self-discovery organizers (GSDOs).

5. Relations performance will be better facilitated by GSDO instruction than will classification performance.

6. (a) Instruction by EO-C (hierarchical classification) will transfer to performance on relations tasks.

6. (b) Instruction by EO-R (relations) will transfer to performance on classification tasks.

(The remaining hypotheses deal with transfer-task performance.)

7. The order of effect of instruction by advance organizer lessons on classification and relations transfer tasks performance will be EO > GSDO.

8. Order of effect from instruction on both cross-classification and spontaneous classification problem-solving performance will be EO-C > EO-R > GSDO-R = C.

9. Order of effect from instruction on both the cross-seriation and one-to-one correspondence problem-solving tasks will be EO-R > GSDO > R = EO-C > GSDO-C = C.

10. Order of effect from instruction on near-far transfer will be EO > GSDO.

11. Order of effect from instruction on far-far transfer will be EO > GSDO.

IV

RESULTS

First, the results of the multivariate analysis of all treatments over all tasks will be reported. Second, the results of a series of univariate analyses comparing each treatment group's performance on all posttests will be reported, followed by the results of Scheffe and Tukey posthoc comparison analyses. Third, the results of within and between treatment group analyses will be presented by task. Finally, the transfer task results will be reported in terms of the same series of analyses. Since all Ss retained for this experiment from the original sample were those who had failed both the classification and seriation pretests, all the analyses reported here were carried out on posttest and transfer data only.

Data from the posttest classification are presented in Table 5, and data for posttest relations tasks are presented in Table 6.

Multivariate Analysis

A multivariate test for equality of mean vectors was first carried out on the posttest data. Factors were treatment group (5) x task (8). This analysis yielded a significant overall variance, $F$ (32, 123 = 2.46, $p < .001$. To determine on which posttest the significant variance occurred, the following univariate analyses were carried out.

TABLE 5

MEAN SCORES AND STANDARD DEVIATIONS ON CLASSIFICATION POSTTESTS

| Classification Task | Score Range | Experimental Group | | | | |
|---|---|---|---|---|---|---|
| | | EO[a] | EO-C[b] | GSDO[c] | GSDO-C[d] | C[e] |
| Multiple Classification Task 1 | 0-2 | 0.6(0.5) | 1.2(0.6) | 0.3(0.5) | 0.3(0.5) | 0.3(0.5) |
| Multiple Classification Task 2 | 0-2 | 0.7(0.4) | 1.3(0.7) | 0.5(0.5) | 0.5(0.5) | 0.3(0.5) |
| Class Inclusion Task 1 | 0-2 | 0.7(0.6) | 1.6(0.7) | 0.4(0.5) | 0.8(0.7) | 0.6(0.8) |
| Class Inclusion Task 2 | 0-2 | 0.4(0.7) | 1.4(0.5) | 1.0(0.7) | 0.8(0.7) | 0.6(0.7) |

[a]E-S : Expository-Relations (N=9)

[b]E-C : Expository-Classification (N=9)

[c]GSDO: Guided self-discovery-Relations (N=9)

[d]GSDO-C: Guided self-discovery-classification (N=9)

[e]C : Control (N=9)

Standard deviations are given in parentheses

TABLE 6

MEAN SCORES AND STANDARD DEVIATIONS ON SERIATION POSTTESTS

| Seriation Task | Score Range | Experimental Group | | | | |
|---|---|---|---|---|---|---|
| | | EO[a] | EO-C[b] | GSDO[c] | GSDO-C[d] | C[e] |
| Additive Seriation Task 1 | 0-2 | 1.6(0.5) | 1.3(0.7) | 1.1(0.9) | 1.0(0.8) | 0.6(0.8) |
| Additive Seriation Task 2 | 0-2 | 1.1(0.9) | 1.2(0.8) | 1.2(0.4) | 1.2(0.9) | 0.5(0.7) |
| 1:1 Correspondence Seriation - Task 1 | 0-2 | 2.0(0.0) | 1.5(0.7) | 1.5(0.5) | 1.1(0.9) | 0.5(0.5) |
| 1:1 Correspondence Seriation - Task 2 | 0-2 | 1.7(0.4) | 0.8(0.6) | 1.0(0.7) | 0.6(0.8) | 0.2(0.4) |

[a]EO : Expository-Relations (N=9)

[b]EO-C: Expository-Classification (N=9)

[c]GSDO: Guided self-discovery-Relations (N=9)

[d]GSDO-C: Guided self-discovery-Classification (N=9)

[e]C : Control

Standard deviations are given in parentheses

Univariate Analyses

A univariate analysis of data from the four classification and four relations posttests indicated significant differences in performance between groups on all four classification tasks and two relations tasks (i.e., both one-to-one correspondence seriation tasks). Results are tabulated in Table 7. The significant differences found were as follows:

Multiple Classification, task 1, $F(4, 40) = 4.69$, $p < .005$, and task 2, $F(4, 40) = 4.37$, $p < .01$;

Class Inclusion, task 1, $F(4, 40) = 3.76$, $p < .01$, and task 2, $F(4, 40) = 2.64$, $p < .05$;

One-to-One Correspondence Seriation, task 1, $F(4, 40) = 6.91$, $p < .001$, and task 2, $F(4, 40) = 7.28$, $p < .001$.

To assess which group(s) these significant differences favored, two posthoc analyses were performed, the results of which are now described.

Posthoc Analyses

Two posthoc analyses were carried out for the posttest data for which analyses had indicated significant variance. First, a series of Scheffe posthoc comparisons (Scheffe, 1953) of posttest scores revealed that the performance of the EO-C group was significantly better than that of the GSDO-R, GSDO-C, and Control groups on both spontaneous classification tasks, and on class inclusion, task 1. Since neither additive seria-

TABLE 7

UNIVARIATE F VALUES FOR POSTTEST VARIATION(S)

| Posttest | Mean Square | Univariate F | df | error term | P value less than |
|---|---|---|---|---|---|
| Multiple Classification Task 1 | 1.3556 | 4.6923 | 4, 40 | .2888 | .005 |
| Multiple Classification Task 2 | 1.3111 | 4.3704 | 4, 40 | .3000 | .01 |
| Class Inclusion Task 1 | 1.9444 | 3.7634 | 4, 40 | .5166 | .01 |
| Class Inclusion Task 2 | 1.2778 | 2.6437 | 4, 40 | .4833 | .05 |
| Additive Seriation Task 1 | 1.2256 | 2.0179 | 4, 40 | .6222 | ns |
| Additive Seriation Task 2 | 0.7556 | 1.1724 | 4, 40 | .6444 | ns |
| 1:1 Correspondence Seriation - Task 1 | 2.6889 | 6.9143 | 4, 40 | .3888 | .001 |
| 1:1 Correspondence Seriation - Task 2 | 2.9111 | 7.2778 | 4, 40 | .4000 | .001 |

tion posttest had shown significant variation, no Scheffe comparisons were performed on these tasks. Further Scheffe comparisons showed that posttest performance of the EO/R group was significantly better than the control and the combination of all the other experimental groups on one-to-one correspondence, task 2, and approached significance on task 1. On one-to-one correspondence task 2 the combined EO/R and EO/C groups significantly outperformed the Control group. Results of this analysis are provided in Table 8.

The second posthoc analysis performed on the posttest data was the Tukey T-test of Gaps Between Means (c.f., Guilford, 1965). A comparison of cell means between combined EI groups and combined GSDO groups revealed a significantly higher level of performance in favor of the combined EO groups ($p < .01$).

Tukey T-tests were performed on all the individual posttests for the various experimental groups. This data showed that (1) the EO/R group significantly outperformed the control group on one-to-one correspondence seriation, task 1 ($p < .01$) and task 2 ($p < .01$) and (2) the EO/C group did significantly better than the GSDO/R group on class inclusion, task 1 ($p < .05$), and approached significance on task 2. Further differences which approached significance include EO/C over controls on class inclusion, task 1, EO/C over EO/R and GSDO/C over GSDO/R on class inclusion, task 2. Other differences which approached significance were EO/R over C (controls) on additive seriation, task 1, and EO/C over C on spontaneous classification, tasks 1 and 2.

TABLE 8

SCHEFFE POSTHOC COMPARISON RESULTS

| Posttest | Groups Compared | F Value | MS Error Term | P Value Less Than |
|---|---|---|---|---|
| Multiple Classification Task (content) 1 | E-C v GSDO-S, GSDO-C, C | 4.37 | 0.2889 | .005 |
| | E-C v C | " | " | " |
| Multiple Classification Task (Content) 2 | E-C v GSD-S, GSD-C, C | 3.83 | 0.300 | |
| | E-C v C | " | " | ns |
| Class Inclusion Task 1 | E-C v GSDO-S | 2.61 | .5166 | .05 |
| | E-C v GSDO-S, GSD-C | " | " | " |
| Class Inclusion Task 2 | E-C v GSDO-C | 2.61 | .4833 | .05 |
| 1:1 Correspondence Seriation - Task 1 | E-S, E-C v C | 5.70 | .3888 | .001 |
| | E-S, E-C v GSDO-S, GSDO-C, C | " | " | " |
| | E-S v C | " | " | " |
| 1:1 Correspondence Seriation - Task 2 | E-S v C | 5.70 | .40 | .001 |
| | E-S v E-C, GSDO-S, GSDO-C | " | " | " |
| | E-S, E-C, GSDO-S, GSDO-C v C | " | " | " |
| | ET-S v GSDO-S, GSDO-C | " | " | " |
| | E-S v E-C | " | " | " |

Within Treatment Group Analyses

Within treatment group analyses of variance for comparison of skill taught yielded the following results with respect to each task:

Spontaneous Multiple Classification - Difference in performance between GSDO-R and GSDO-C was not significant for either task 1 or task 2, while the difference between performance by EO-R compared to EO-C approached significance (favoring the EO-C group) on both tasks, F (1, 16) = 3.85, n.s.

Class Inclusion - No significant differences were found between GSDO/R and GSDO/C on either task 1 or task 2. On task 1, EO-R versus EO-C yielded a significant difference, favoring EO-C, F (1, 16) = 7.58, p < .05, and on task 2 another significant difference between EO-C and EO-R was found, F (1, 16) = 10.55, p < .01.

Additive Seriation - No significant differences were found between the performance of any of the treatment groups on either task 1 or 2.

One-to-One Correspondence Seriation - Differences in performance between GSDO-R and GSDO-C were not significant on either task 1 or 2. EO-R compared to EO-C approached significance on Task 1, F (1, 16) = 3.36, n.s., and yielded a significant difference on Task 2, F (1, 16) = 12.45, p < .01.

Between Treatment Groups Analyses

A series of F tests were completed on the posttest data for between group comparisons. These results are reported in Table 9.

TABLE 9

ANALYSIS OF VARIANCE RESULTS - POSTTEST SCORES

| Posttest(s) | Treatment Groups | df | F | P Value | Favoring |
|---|---|---|---|---|---|
| Total of all posttests | E-C[a] v C[b] | 1, 16 | 18.5 | .005 | E-C |
| " | E-S[c] v C | 1, 16 | 15.6 | .01 | E-S |
| " | GSD-S[d] v C | 1, 16 | 5.00 | .05 | GSD-S |
| " | GSD-C[e] v C | 1, 16 | 2.99 | ns | |
| " | GSD-C v E-C | 1, 16 | 5.70 | .05 | E-C |
| " | GSD-S v E-S | 1, 16 | 1.57 | ns | |
| " | E-C v E-S | 1, 16 | 1.46 | ns | |
| " | GSD-S v GSD-C | 1, 16 | 0.13 | ns | |
| Total of all classification posttests | E-C v GSD-C | 1, 16 | 12.23 | .001 | E-C |
| Total of all seriation posttests | E-S v GSD-S | 1, 16 | 3.65 | ns | |

[a]E-C: Expository-Classification (N=9)

[b]C : Control (N=9)

[c]E-S: Expository-Seriation (N=9)

[d]GSD-S: Guided self-discovery-Seriation (N=9)

[e]GSD-C: Guided self-discovery-Classification (N=9

—Indicates in favor of that treatment group.

First, treatment groups combining skill areas taught were compared on overall posttest totals. Expository taught groups did significantly better than both controls and GSDO taught groups on posttest totals ($p < .01$). Next, individual groups were compared on total posttest score performance. Children in the EO-C group did significantly better than controls, $F\ (1, 16) = 18.5$, $p < .005$, and EO-R Ss also outperformed controls, $F\ (1, 16) = 15.6$, $p < .01$, as did GSDO-R Ss on total posttest scores, $F\ (1, 16) = 5.0$, $p < .05$. Results of F tests on total posttest scores for EO-R compared to GSDO-R indicated no significant difference in performance. This was also the case for GSDO-C versus control.

Further F tests were performed for posttest scores in particular skill areas to assess specific transfer. A comparison of EO-C versus GSDO-C groups revealed a significant difference in classification posttest scores (i.e., all spontaneous classification and class inclusion tests), $F\ (1, 16) = 12.23$, favoring the EO-C group. A similar comparison of relations posttest scores for EO-R versus GSDO-R groups (over all additive and one-to-one correspondence seriation tasks) showed no significant differences between the performance of these two groups, though a trend on these tasks favored the EO-R group.

Transfer Task Data (and Posthoc Analyses)

Data from the transfer tasks are presented in Table 10. Of the seven transfer tasks given, only the first (i.e., cross-classification 3 x 3 matrix) showed significant variance on the multivariate analysis [$F\ (4, 40) = 2.59$, $p < .05$]. Scheffe posthoc analyses on this task

TABLE 10

MEAN SCORES ON TRANSFER TASKS

| Transfer Task | Score Range | Experimental Group | | | | |
|---|---|---|---|---|---|---|
| | | EO[a] | EO-C[b] | GSDO[c] | GSDO-C[b] | C[e] |
| Cross-Classification 3 x 3 matrix* | 0-2 | 1.2(0.6) | 1.4(0.7) | 0.6(0.7) | 0.8(0.6) | 0.6(0.5) |
| Cross-Seriation 3 x 3 matrix | 0-2 | 1.0(0.8) | 0.8(0.7) | 0.5(0.5) | 0.4(0.7) | 0.5(0.7) |
| Problem Solving: Spontaneous Classification | 0-2 | 1.3(0.7) | 1.3(0.7) | 0.6(1.0) | 1.4(0.8) | 0.7(0.9) |
| Problem Solving: One-to-One Correspondence Seriation | 0-2 | 1.4(0.5) | 1.3(0.5) | 1.1(0.9) | 0.6(0.8) | 0.6(1.0) |
| Conservation of Area: Identity | 0-2 | 0.4(0.8) | 1.1(1.0) | 0.8(1.0) | 0.4(0.8) | 0.2(0.6) |
| Conservation of Area: Equivalence | 0-2 | 0.6(1.0) | 0.8(1.0) | 0.0(0.0) | 0.2(0.6) | 0.2(0.6) |
| Conservation of Number | 0-2 | 0.6(1.0) | 0.8(1.0) | 0.4(0.8) | 0.6(1.0) | 0.4(0.8) |

* : Significant variance ($p < .05$)

[a]EO-R: Expository-Relations (N=9)

[b]EO-C: Expository-Classification (N=9)

[c]GSDO-S: Guided self-discovery-Relations (N=9)

[d]GSDO-C: Guided self-discovery-Classification (N=9)

Standard deviation scores are given in parentheses showed that EO-C and EO-R groups tended to achieve a superior performance compared to all other groups. This difference approached significance. On transfer task 2 (cross-seriation 3 x 3 matrix) the EO-R group's superior performance over GSDO-C, GSDO-R, and C approached significance. On the third transfer task (classification problem-solving), the trend toward superior performance favored both expository taught groups and the GSDO-C group. On transfer task 4 (seriation problem-solving), there was a similar trend, favoring both expository taught groups and GSDO-R groups over GSDO-C and C groups.

The final three transfer tasks dealt with conservation and showed the least variation of all the transfer tasks. Tasks 5 and 6 tested conservation of area (identity and equivalence). There were no significant differences between identity conservation and equivalence conservation mean scores, although the EO-C group did slightly better than the other groups on conservation of area - identity. On the final transfer task (conservation of number: Task 7) no differences between groups approached significance.

It is quite clear that very little positive near-far (e.g., hierarchical classification to cross-classification) or far-far (e.g., hierarchical classification or relation to conservation) transfer occurred. It is interesting to observe, however, that certain important transfer-trends did occur. The strongest trends were between like skill areas or what appear to be closely related skill areas (i.e., classification and seriation).

V

DISCUSSION

The results will be discussed in terms of the major hypotheses stated in Chapter II. This will be followed by a discussion of theoretical questions raised by the present study, practical applications of the findings, and recommendations for further research.

The first hypothesis, which predicted that the overall posttest performance of the AO groups would be significantly better than that of the controls, was generally supported by the results. EO-C, EO-R, and GSDO-R groups significantly outperformed the controls on overall posttest scores (see Fig. 2).

The second hypothesis, which stated that performance on classification and seriation posttests would be improved by AO instruction, was supported. Both AO groups significantly outperformed the controls in the skill area taught (i.e., classification or relations).

Hypothesis 3 predicted that the most significant improvement on posttest scores would be in the skill area taught, as compared to the posttest scores on tests assessing the skill not taught. This prediction was supported by the classification posttest data. It was also partially supported by the relations posttests, in which there was a consistent trend favoring the EO-R group on all relations

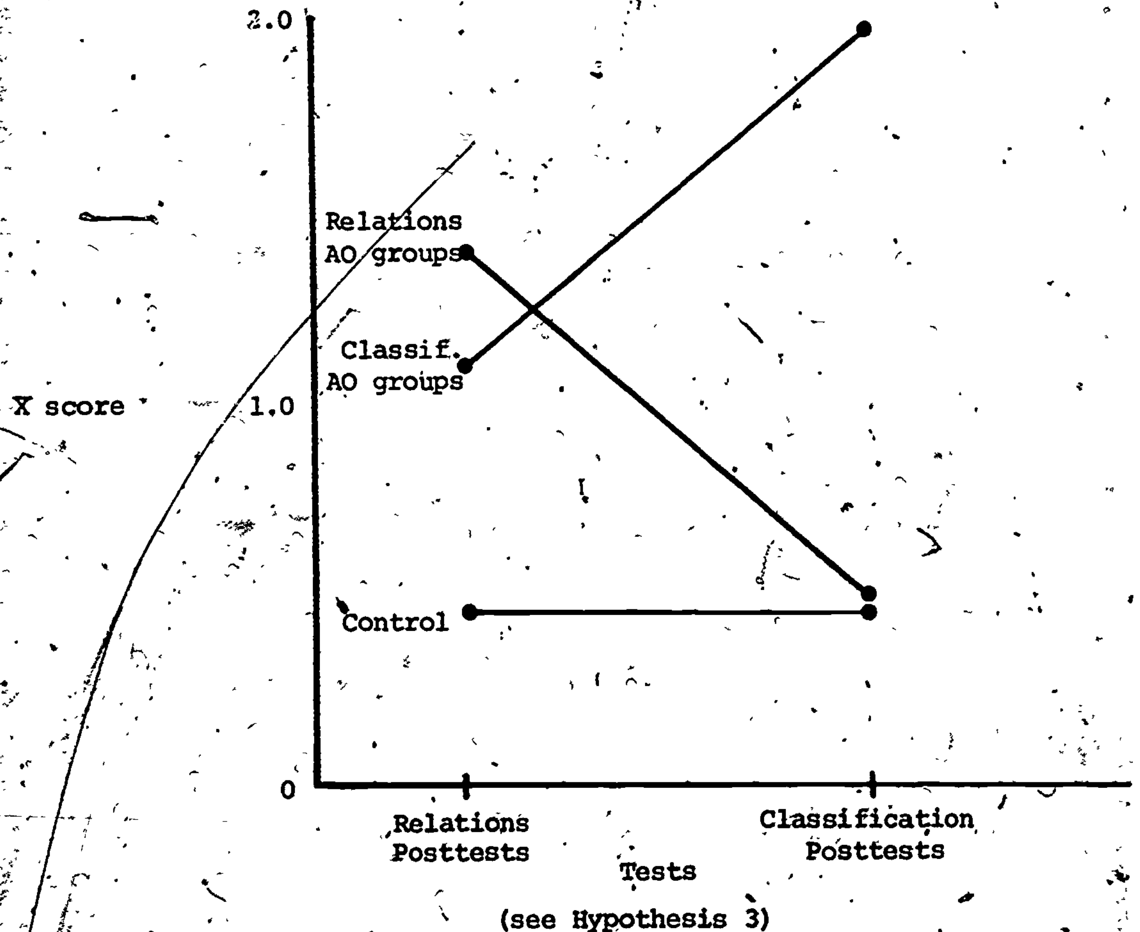
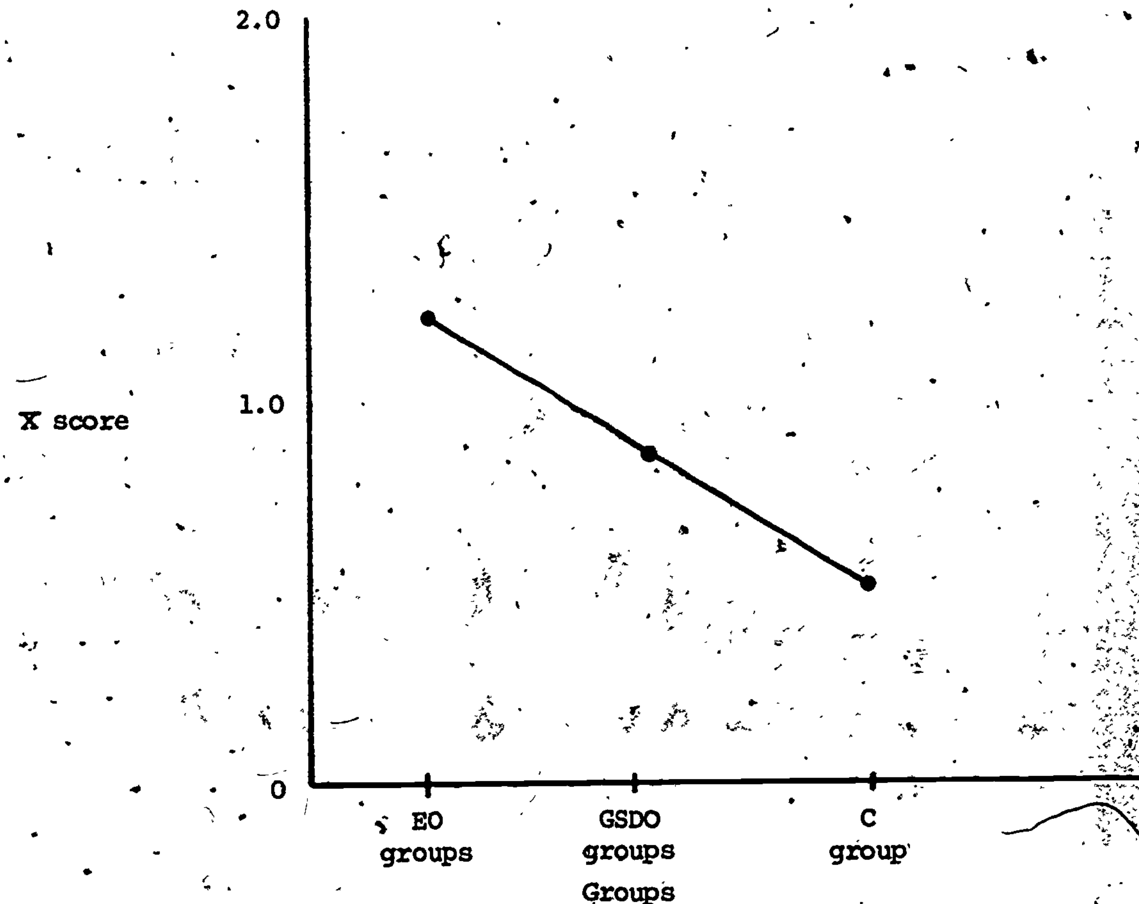



Figure 1. Total mean posttest scores on relations and classification tasks for each treatment group.




(see Hypotheses 1 and 4)

Figure 2. Mean scores for combined posttests by treatment group

posttests (see Fig. 1).

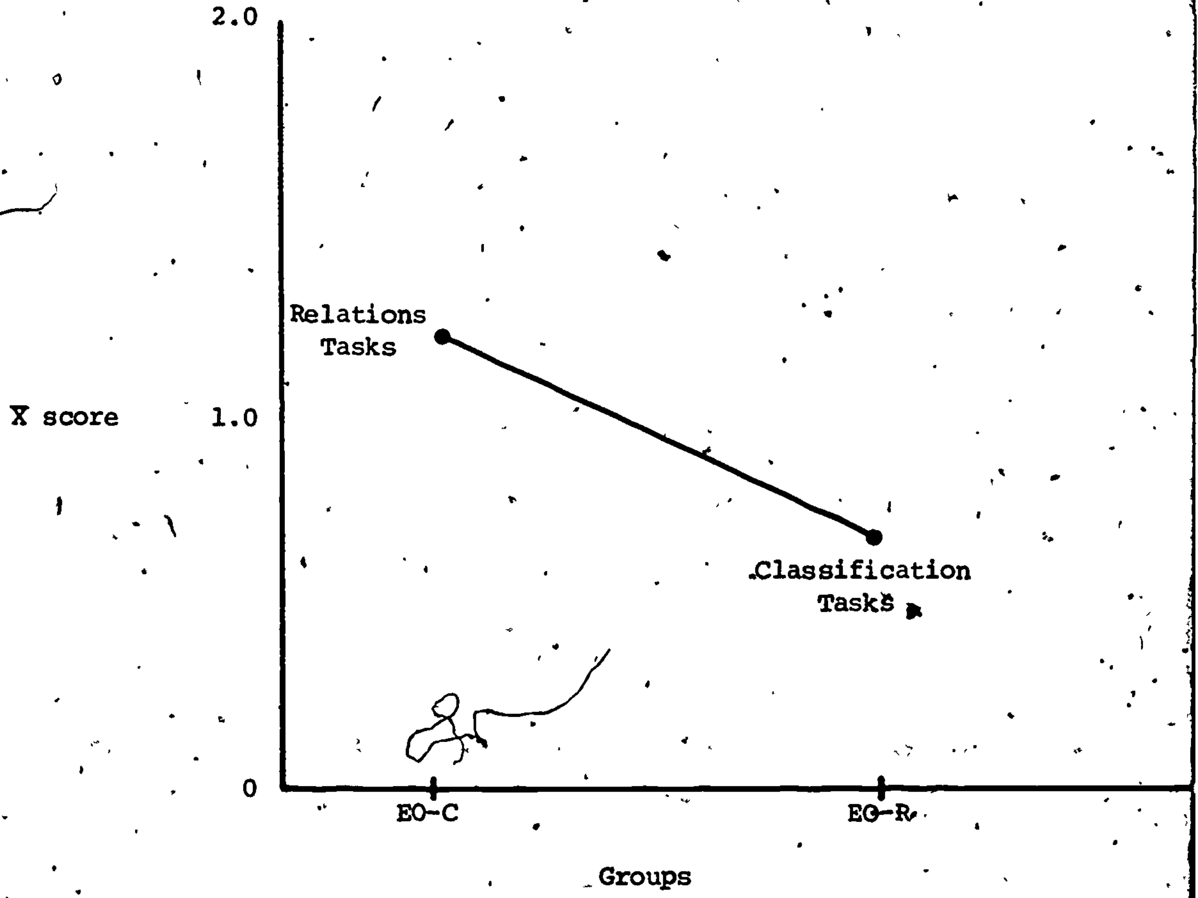
The fourth hypothesis, which predicted significantly better performance on posttest tasks by EO groups as compared to GSDO groups was supported in terms of overall posttest performance, in which EO groups significantly outperformed GSDO groups (see Fig. 2). Within the tasks measuring skill area taught, the results indicated that the EO-C group significantly outperformed the GSDO-C group on classification posttests. A trend favored the EO-R group over the GSDO-R group on relations posttests, with the exception of additive seriation, Task 2. The fact that significant differences were found between EO-C and GSDO-C and not for EO-R and GSDO-R is consistent with hypothesis 5, which predicted that relations performance would be more sensitive to GSDO training than classification. Thus, the difference between EO-R and GSDO-R scores was not expected to be as great as that between EO-C and GSDO-C scores. In terms of order of skill emergence, this result lends support to the relations < classification order of skill emergence.

Hypothesis 6(a), which predicted that EO-C training would result in nonspecific transfer to relations, was supported (see Fig. 3). The results indicated no significant differences between EO-C and EO-R groups' performance on relations posttests. This finding lends further support to the view that (a) classification is a later emerging skill than relations, and (b) that relations skills are subsumed under hierarchical classification skills.

Hypothesis 6(b) further predicted that EO instruction in relations would result in non-specific transfer to classification posttests. This prediction was not supported by the results, which showed significantly better performance on classification tasks by the EO-C group than the EO-R group (see Fig. 3). Thus, relations training appeared to have a more linear function. That is, relations training led to near-far transfer to other, more difficult or later emerging relations tasks, but led to no significant far-far transfer to classification tasks. This can be contrasted to the more hierarchical nature of classification training, which appeared to subsume relations in the present study. In terms of the discussion on the efficiency of instruction referred to previously, it would appear that teaching high-order hierarchical classification rules, using an expository approach, leads to the greatest transfer of training, including far-far transfer to relations tasks.

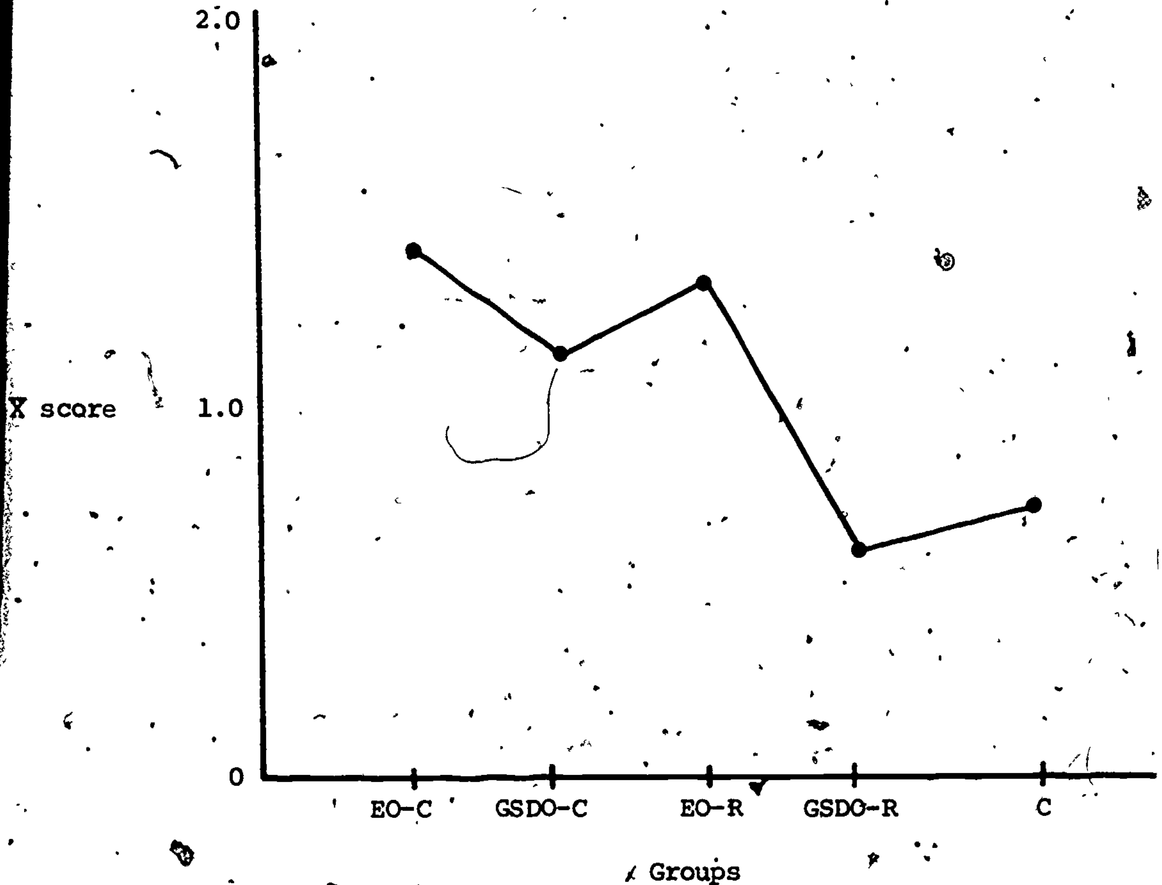
The remaining hypotheses dealt with transfer task performance. Hypothesis 7, which predicted that EO groups would outperform GSDO groups on classification and relations transfer tasks, was supported by the results. It can be observed from the data in Table 10 that there is a consistent trend for the EO groups to outperform the GSDO and control groups on all classification and relations transfer tasks (see Fig. 4).

Hypotheses 8 and 9 are concerned with orders of effect on transfer tasks. Since the only transfer task to have a significant be-




(see Hypothesis 6)

Figure 3. Comparison of nonspecific transfer for EO-C versus EO-R groups.




(see Hypotheses 7 and 8)

Figure 4. Mean scores for cross classification and spontaneous classification problems by treatment group.

tween group difference was the cross classification task, this will be discussed first. In discussing the remaining transfer hypotheses, trends evidenced in the data in Table 10 will be referred to.

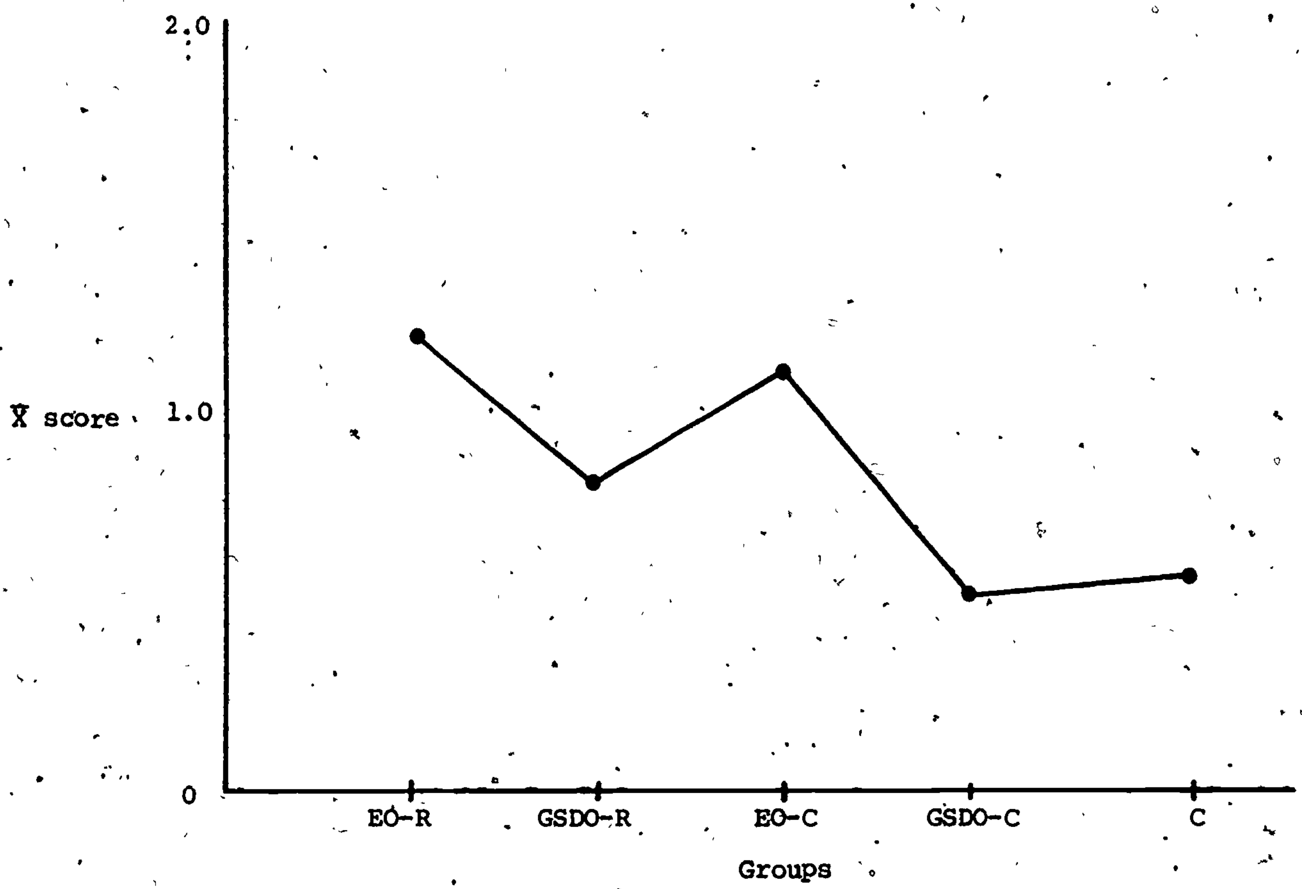
The order of effect predicted in hypothesis 8 for cross classification was EO-C > GSDO-C > EO-R > GSDO-R = C, and the actual order of effect was EO-C > EO-R > GSDO-C > GSDO-R = C (see Fig. 4). This clearly demonstrates the superior performance of both EO groups over the GSDO and control groups. As predicted, the GSDR-R and control group performed at the same level, with identical mean scores on the cross classification task. The fact that the GSDO-C group did not outperform the EO-R group can be viewed as further evidence of the relative difficulty of classification skills, (or their later emergence) and the superior efficiency of the EO presentation method. The same order of effect listed first above was predicted by hypothesis 8 for the spontaneous classification problem solving task. The actual order of effect was EO-C = EO-R = GSDO-C > GSDO-R = C (see Fig. 4). Though none of these differences reached significance, there was a strong trend favoring both EO groups and the GSDO-C group over GSDO-R and control groups. Again, the superiority of expository presentation was evidenced by the fact that there was no difference in mean scores on this task between the two expository groups and the GSDO-C group.

The way in which expository training on relations should transfer to solving a problem requiring classification is not readily apparent. If, as some of the previously reviewed literature suggests, classification skills emerge subsequent to relations skills, it is possible that EO training of relations might transfer in a linear fashion to spontaneous classification, generally considered among the first types of classification to emerge. It would also appear that an expository presentation method enhances such transfer to a greater degree than a GSDO method, as evidenced by the fact that the GSDO-R group did no better than the controls.

The fact that such nonspecific transfer from relations training to spontaneous classification occurred only for the spontaneous classification problem, and not on the classification posttests may be a function of a difference in task demands between posttests and the transfer problem. The transfer problem was, for example, scored on only two responses, that is, making the appropriate groupings and answering a question regarding the number of groups made. In contrast, both spontaneous classification posttests had the possibility of three exhaustive sorts and required the labeling of groups in some way, with a possibility of 19 responses. The class inclusion posttests also involved more possible responses than the problem-solving task. This, combined with the finding that class inclusion tasks are more difficult than spontaneous classification (e.g., Hooper et., 1974; Kofsky, 1966) might have had an effect on the further difference noted between the posttests, and transfer problem. The class inclusion tests also required an appropriate reason or demonstration of sub- and superordinate relationships. The spontaneous classification problem did not require such an understanding, but merely required the child to make sub-groupings among animals and state a number of "cages" based on the number of groups made.

Hypothesis 9 predicted that the order of effect on both the cross seriation and one-to-one correspondence seriation problem would be EO-R > GSDO-R = EO-C > GSDO-C = C based on the argument regarding the efficiency of EO instruction and the hypothesized subsumption of relations by classification. Observation of data in Table 10 will indicate that although there was not a significant difference between group performance, the order of effect for the cross seriation task was EO-R > EO-C > GSDO-R > GSDO-C = C (see Fig. 5). The efficiency of the EO presentation style compared to both the GSDO and control formats was again demonstrated, with a strong trend favoring both EO groups. The fact that the EO-C group outperformed the GSDO-R group on cross seriation adds further evidence to the order of emergence or subsumption issue discussed above, and gives some indication of the degree to which hierarchical classification facilitates cross seriation performance.

The order of effect for the one-to-one correspondence seriation problem was EO-R = EO-C > GSDO-R > GSDO-C = C (see Fig. 5). Once again, the effectiveness of the EO method was demonstrated, with EO-C, EO-R, and GSDO-R groups performing at a higher level than GSDO-C or C groups. As stated in hypothesis 11, such far-far trans-




(see Hypothesis 9)

Figure 5. Mean scores for cross seriation and one-to-one correspondence seriation problem by treatment group.

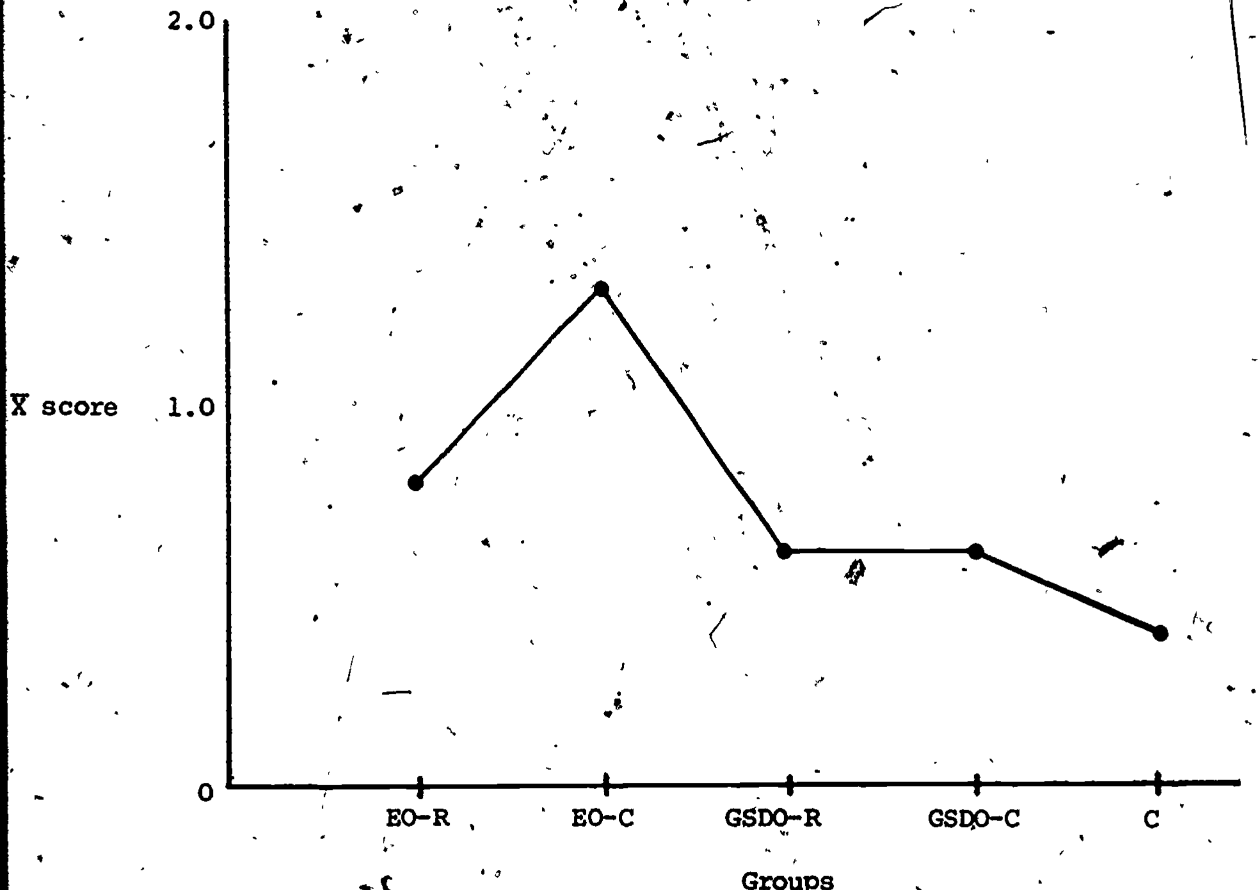
fer to the relations transfer tasks was expected for the EO-C group. The fact that the trends of the transfer data consistently favor the EO groups, especially the EO-C group, indicates that learning following EO lessons was more durable and showed the greatest degree of generalization or transfer. By definition, more meaningful learning had occurred following the EO sequences than in the other groups. Though no delayed posttests were given, the fact that EO-S groups retained concepts taught for up to five weeks after AOs took place, and transferred these concepts to matrix and problem-solving tasks five to six weeks after treatment, indicates that retention was also greatest for those children in EO groups.

Hypothesis 10 predicted that the greatest amount of near-far transfer from skill taught to related transfer tasks would be shown by EO groups. This prediction was supported by the consistent trend, previously discussed, for EO groups to outperform GSDO and controls both in transfer tasks assessing the skill area taught. Comparing the performance of EO-R and EO-C groups on the transfer tasks (as indicated by data in Table 10), it is clear that transfer was greatest in the area of instruction, i.e., the relations group did somewhat better on relations transfer tasks and the classification group did better on classification transfer tasks. The lack of both near-far and far-far transfer for all GSDO groups again indicates the superiority of the EO presentation style.

The eleventh, and final hypothesis, which predicted that far-far transfer to conservation of area or number would occur for all groups, was not supported. All groups failed both the conservation of area and conservation of number tests, with no significant differences or trends between groups. The EO-C group did slightly better than the other groups on combined conservation tasks, with the greatest difference on conservation of area-identity, which is generally considered less difficult than equivalence conservation (see Fig. 6). The EO-C group had a mean score of 1.1 on this task, i.e., passing Level II. Differences between the treatment groups were smallest for the conservation of number tasks, with all groups failing.

The evidence of a lack of far-far transfer to conservation supports the asynchronous skill development argument, which runs counter to the Genevan structures-of-the-whole hypothesis. According to the Genevan view, it would be predicted that far-far transfer to conservation tasks should occur following successful training of another concrete operation, such as classification or relations. The fact that far-far transfer from EO-C to conservation was not generally found, while some transfer to various relations tasks did occur indicates the need for further clarification of this concept.

According to Brainerd's (1975) definition, "far-far transfer would consist of improvement in concrete operational skills which do not involve the (trained) principle." This definition does not differentiate between far-far transfer to a skill (e.g., relations),




(see Hypothesis 11)

Figure 6. Mean scores on combined conservation tasks by treatment group.

thought to emerge prior to the skill taught (e.g., classification), from a later emerging skill (e.g., conservation). Relations tasks, in the present case, were more easily facilitated after training on classification, which, from the asynchronous point of view, would emerge later and subsume relations. Though such transfer seems quite different from transfer to conservation, both fall under the same category label of "far-far" transfer in Brainerd's model.

It would appear that at least two types of far-far transfer are entailed in the structures-of-the-whole hypothesis. These should be considered and compared in future studies.

To summarize the main conclusions of this study, the use of an advance organizer sequence was successful in facilitating the concrete operational skills of relations and hierarchical classification. The most efficient presentation method was found to be expository, as compared to guided self-discovery. The durability and retention of the learning of EO groups was evidenced by their consistently outperforming the other treatment groups on posttests and transfer tasks relating to the skill taught. Some nonspecific transfer was noted for the EO-HC group, and this was viewed in terms of the later emergence and subsumptive characteristics of classification, as compared to the assumed earlier emergence of relations. The greater relative difficulty of classificatory tasks was evidenced by the significant difference in presentation style results on classification tasks (favoring EO), while the difference on relations tasks only approached significance.

The above results are viewed as lending support to the asynchronous model of concrete operational skill development, with the need for a better delineation of the types of far-far transfer suggested.

The use of a small group instructional method, employing an expository teaching approach and using a story-like format to convey high-order ideas, accompanied by concrete exemplars, was found to be successful in facilitating meaningful learning of both relations and classification, as evidenced by the posttest results. Such a method could be easily applied in typical preschools. This teaching approach might prove to be a far more powerful vehicle for meaningful learning of both content and process concepts if it were to be continued for the duration of the "school year" as compared to the limited duration of teaching in this study.

To enlarge on the applicability of employing hierarchically organized expository AO sequences in the early childhood classroom, a brief discussion of the Ausubelian Program at the University of Wisconsin Child Study Center will conclude this section. This program has utilized an AO small group format for over two years, in teaching both content and process concepts to children aged 2.5 through 6 years. Subject matter taught has included concrete operational skills, mathematics, science, art, social studies, music, language and pre-reading, and skill, subject matter, and socio-emotional problem solving. Teaching of these areas has taken place one-to-one and in a large group, in addition to the usual small group (four or five children) format. A battery of tests (see Lawton et al., in preparation) showed significant gains in performance following such AO instruction, as compared to a control group, and outperformed a Piagetian self-discovery group on the more difficult concrete operational tasks (e.g., conservation,

The success of this project and other potential applications of Ausubel's theory to early childhood education depend largely on the amount and quality of pre-planning and content analysis of any area which will be presented. In order to teach concepts which are hierarchically related in a meaningful way, the establishment of such a hierarchy is critical. In order to provide the learner with the broadest frame of reference in which to fit new ideas, the most general and inclusive ideas should be presented first, and should progress into more detailed or specific information at whatever pace the learner(s) require. This is also a crucial point, since the major purpose of providing an organizer is to meaningfully relate new concepts to existing ideas.

The role of concrete props, interesting materials, and a variety of related activities are also essential to teaching young children such subject matter as described above. This requires making materials appropriate to both the age of the learner and the subject matter presented. Such materials are rarely available, making the construction of materials another aspect of the AO approach. In other words, rather than finding existing materials considered interesting and then planning a lesson based on these materials, the AO concepts are generated first, and the appropriate materials then gathered or made. Such materials are used both to provide concrete exemplars of concepts presented in the AO, and to provide many materials to which children can apply or generalize concepts presented in AOs. Related activities (RAs) perform perhaps the most valuable role in assessing children's understanding of AO concepts. providing practice and transfer situations, and making the concepts more interesting or entertaining for the learners (e.g., use of games, treasure hunts, art projects, problem-solving situations in a story format, etc.).

Related activities also give the teacher an opportunity to work with the children one-to-one, and concentrate on individual needs. RAs are presented in a structured choice format. That is, following the AO lesson, the related activities are demonstrated or described, and the children can choose one or more activity. After completion of RAs related to the AO just presented, children often move to RAs related to AOs in other subject-matter areas, which they have had earlier in the day or week. This provides further reinforcement and opportunity for transfer of AO concepts.

To conclude, the results of the present study, combined with the results of the Ausubelian Program and other recent applications of AO instruction, indicate that such hierarchically organized and direct presentation method is both a viable and an effective means of teaching young children.

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APPENDIX A

TEST PROTOCOLS

SPONTANEOUS CLASSIFICATION - Tasks 1 & 2

Materials: 1. ____________________

2. ____________________

Procedure: E names individual items for S, then says, I WOULD LIKE YOU TO PUT THESE THINGS INTO GROUPS. WHEN YOU HAVE PUT THEM INTO GROUPS I AM GOING TO ASK YOU TO NAME EACH GROUP AND TELL ME WHY YOU PUT THINGS INTO EACH GROUP.

1. CAN YOU PUT THESE ( ) INTO GROUPS?

WHAT NAME (or, WHAT ARE YOU GOING TO CALL) ARE YOU GOING TO GIVE TO THESE GROUPS?

Names: 1. ____________________

2. ____________________

3. ____________________

E then asks, WHY DID YOU PLACE THESE ____________ INTO THESE GROUPS?

Reason(s): ____________________

____________________

Items not used in 1st sort: ____________________

Items misplaced in 1st sort: ____________________

Then E says: (mixing materials back together)

2. CAN YOU PUT THEM INTO GROUPS A DIFFERENT WAY?

WHAT NAME ARE YOU GOING TO GIVE TO THESE GROUPS?

Names: 1. ____________________

2. ____________________

3. ____________________

E then asks, WHY DID YOU PLACE THESE ________________ INTO THESE GROUPS?

Reason(s): ____________________

____________________

Items not used in 2nd sort: ____________________

Items misplaced in 2nd sort: ____________________

E then asks:

3. CAN YOU PUT THESE ( ) INTO ( No. ) GROUPS?

WHAT NAME ARE YOU GOING TO GIVE TO THESE GROUPS?

Names: 1. ____________________

2. ____________________

3. ____________________

E then asks, WHY DID YOU PUT THESE ________________ INTO THESE GROUPS?

Reason(s): ____________________

____________________

Items not used in 3rd sort: ____________________

Items misplaced in 3rd sort: ____________________

SERIAL CORRESPONDENCE - Tasks 1 & 2

Materials: (a) 7 fish, increasing in size; 7 worms, increasing in size; Task 2: **(b) 7 firemen, increasing in size; 7 ladders, increasing in size

Preparation:

E placed the fish in a seriated row on the table, with smallest fish to S's left, saying:

THESE FISH ARE PLACED NEXT TO EACH OTHER IN A SPECIAL ORDER.

E then presents the worms to S in a mixed array, saying:

SOME OF THESE WORMS ARE BIGGER THAN OTHERS JUST LIKE SOME OF THESE FISH ARE BIGGER THAN OTHERS.

Explanation:

E says:

NOW LET'S MATCH EACH WORM SO THAT THE RIGHT SIZE FISH CAN CATCH IT. EACH FISH WILL EAT A WORM THAT'S THE SAME SIZE. I'LL PUT THE BIGGEST WORM NEXT TO THE BIGGEST FISH. (E places biggest worm in 1:1 correspondence with biggest fish.) NOW YOU PUT THE SMALLEST WORM WITH THE SMALLEST FISH. (E corrects S if necessary.) NOW PUT EACH OF THESE WORMS WITH THE FISH THAT IT GOES WITH. FIND THE RIGHT WORM TO GO WITH EACH FISH THAT IS LEFT.

1) Needed help matching smallest worm (ladder) to smallest fish (fireman). yes____ no____

2) Indicate placement of worms:

fish: 1 2 3 4 5 6 7

worms: ___ ___ ___ ___ ___ ___ ___

3) Number placed correctly by S: 0 1 2 3 4 5 (circle no.)

E completes task if necessary.

E then moves the seriated line of worms away from the fish and extends the array of worms so there is an extra worm at each end of the corr.

E says:

NOW WE ARE GOING TO FEED WORMS TO THESE FISH. LOOK AT THIS WORM (#4). I WANT TO KNOW WHICH SIZED FISH WOULD EAT THIS SIZED WORM. WILL YOU HELP ME FIND THE FISH THAT WE CAN FEED THIS WORM TO? LET'S PUT THIS SIZED WORM BELOW THE FISH WE THINK WOULD EAT HIM.

Repeat with worm no.'s 2 and 6.

4) Write in what # fish S chose to go with each worm presented:

| | worm no. (fireman) | fish no. (ladder no.) |
|---|---|---|
| 4a | 4 | ______ |
| 4b | 2 | ______ |
| 4c | 6 | ______ |

E then mixes the worms up (keeping numbers 5, 6, & 3 at the boundary of the group) and says:

NOW ALL THE WORMS ARE PLAYING OVER THERE. WE WANT TO FEED SOME OF THE FISH, SO WE MUST FIND THE RIGHT SIZED WORMS. HERE IS A WORM WE WANT TO FEED TO ITS RIGHT SIZED FISH. WHICH FISH WOULD LIKE TO EAT THIS WORM? / YOU CAN DO ANYTHING YOU WANT TO FIND OUT WHICH FISH WOULD LIKE TO EAT THIS WORM. (Choose worms #5, 6, & 3.)

5) Write in what # fish S chose to go with each worm presented:

| | worm no. (fireman) | fish no. (ladder) |
|---|---|---|
| 5a | 5 | ______ |
| 5b | 6 | ______ |
| 5c | 3 | ______ |

For each of above, check strategy S employed:

| | random (guess) | measure | reconstruct series |
|---|---|---|---|
| 5a | ______ | ______ | ______ |
| 5b | ______ | ______ | ______ |
| 5c | ______ | ______ | ______ |

Comments:

** = When using task 2 materials (firemen and ladders) change words on test recording sheet and change explanation, i.e., "Each fireman will need a ladder his same size . . . let's find out which fireman this ladder would belong to," etc.

## ADDITIVE SERIATION - Task 1

Materials: 7 fish, of increasing size
3 sticks, of increasing size

Preparation:

E places the middle size and shortest sticks next to each other on table, with longest stick to S's right. The third, and longest stick is placed on the table away from the others. E says:

HERE I HAVE TWO STICKS. THEY GO FROM LONGEST TO SHORTEST. HERE I HAVE ANOTHER STICK. I WANT TO ADD IT TO THESE OTHER TWO STICKS SO THAT THE ORDER IS STILL FROM LONGEST TO SHORTEST. WHERE SHOULD I PUT IT? CAN YOU PUT IT IN THE RIGHT PLACE FOR ME?

Correct _______ Incorrect _______

(If incorrect, put stick in correct position, asking: DOES IT LOOK LIKE ALL THE STICKS GO FROM BIGGEST TO SMALLEST NOW? yes____ no ____)

E removes the sticks and puts out 5 fish (numbers 1, 3, 4, 6, & 7), saying:

HERE ARE SOME FISH. LET'S LINE THEM UP WITH THE SMALLEST FISH HERE, SO THEY GET BIGGER AND BIGGER. (E places the 5 fish in sequence with the smallest fish to S's left and with spaces between the fish.)

Explanation:

E places fish number 2 and 5 (randomly) near S and says:

OH, THERE ARE TWO MORE FISH. YOU PUT THEM WITH THE OTHER FISH SO THAT THE LINE STILL GOES FROM THE SMALLEST FISH TO THE LARGEST FISH. EACH FISH SHOULD SWIM IN SO THAT THERE IS A SMALLER FISH ON ONE SIDE AND A LARGER FISH ON THE OTHER SIDE.

If S fails to get the idea, E places one of the fish in line. After S has finished, E asks, HAVE YOU GOT ALL THE FISH THE WAY YOU WANT THEM? CHECK AND MAKE SURE.

1) Help necessary: Yes _____ No _____

2) Final arrangement of fish: indicate number and position of each one placed.

______ 1 ______ 2 ______ 3 ______ 4 ______ 5 ______ 6 ______ 7 ______

3) Number of fish S places correctly: 0 1 2 (circle no.)

Repeat using tumblers of colored water.

ADDITIVE SERIATION - Task 2

Materials: 7 tumblers of colored water, with increasing amounts of water (order by color: R, G, Y, G, Y, R, R)
3 sticks, increasing length

Preparation:

E places the middle size and longest sticks next to each other on table, with shortest stick to S's left. The third, and longest stick is placed on the table away from the other two. E says:

HERE I HAVE TWO STICKS. THEY GO FROM SHORTEST TO LONGEST. HERE I HAVE ANOTHER STICK. I WANT TO ADD IT TO THE OTHER TWO STICKS SO THAT THE ORDER IS STILL FROM SHORTEST TO LONGEST. WHERE SHOULD I PUT IT? CAN YOU PUT IT IN THE RIGHT PLACE FOR ME?

Correct _______ , Incorrect _______

(If incorrect, put stick in correct position, asking, DOES IT LOOK LIKE ALL THE STICKS GO FROM SHORTEST TO LONGEST NOW? Yes ____ no ____)

E removes the sticks and puts out 4 tumblers of colored water (no.'s 1, 3, 5, 7), saying:

HERE ARE SOME GLASSES OF WATER. LET'S LINE THEM UP SO THE GLASS WITH THE MOST WATER IN IT HERE, SO EACH GLASS HAS LESS AND LESS COLORED WATER. (E places the 4 glasses in sequence with the glass with most water to S's left, leaving spaces between the glasses.)

Explanation:

E places glasses number 2, 4, 6 (randomly) near S and says:

OH, THERE ARE THREE MORE GLASSES. YOU PUT THEM WITH THE OTHER GLASSES SO THAT THE LINE STILL GOES FROM THE GLASS WITH THE MOST WATER IN IT TO THE GLASS WITH THE LEAST WATER IN IT. EACH GLASS SHOULD HAVE A GLASS WITH MORE ON ONE SIDE OF IT AND A GLASS WITH LESS ON THE OTHER SIDE OF IT.

If S fails to get idea, E places one of the glasses in line. After S has finished, E asks, HAVE YOU GOT ALL THE GLASSES THE WAY YOU WANT THEM? CHECK AND MAKE SURE.

1) Help necessary: Yes _______ No _______

2) Final arrangement of glasses: indicate no. and position of each placed.

_______ 1 _______ 3 _______ 5 _______ 7 _______

3) Number S places correctly: 0 1 2 3 (circle number)

## CLASS INCLUSION (Hierarchical Classification) - Task 1

(Three subgroups)

Materials: 5 girl pictures, 4 boy pictures, 6 mother pictures

Procedure:

E shows S all the people and says: HERE ARE SOME PEOPLE. THEY'RE ALL PEOPLE, BUT SOME OF THE PEOPLE ARE GIRLS AND SOME OR THE PEOPLE ARE BOYS, AND SOME OF THE PEOPLE ARE MOMMIES. LET'S SEE HOW MANY GIRLS WE HAVE. FIRST, TAKE ALL THE GIRLS OVER HERE AND COUNT THEM. (If S does not begin quickly to count alone, or counts incorrectly, E says, LET'S COUNT THEM TOGETHER and helps S count.) When S finishes counting, E repeats, THAT'S RIGHT, THERE ARE FIVE GIRLS IN THIS GROUP.

Next, E asks S to put all the boys next to the girls in another group. NOW COUNT ALL THE BOYS. (Again, assist S in counting, if needed.) Then say, THE BOYS AND GIRLS ARE CHILDREN. COUNT ALL THE CHILDREN.

NOW LET'S COUNT ALL THE MOTHERS. (Assist if necessary)

Place all the mothers in a group next to the group of boys and the group of girls, saying: WE HAVE FIVE GIRLS, FOUR BOYS, AND SIX MOTHERS. HOW MANY PEOPLE DO WE HAVE?

Could count all the sub-groups and all the people:

1a) counted girls unassisted: yes _____ no _____
1b) counted boys unassisted: yes _____ no _____
1c) counted mothers unassisted: yes _____ no _____
1d) counted people unassisted: yes _____ no _____

When this task is completed, E mixes up the people and asks:

2) ARE THERE MORE BOYS OR MORE PEOPLE?

a) Response: ______________________________

b) Check: WHEN YOU SAY THERE ARE MORE __________, WHICH ARE THE __________ AND WHICH ARE THE __________?

S's response: ______________________________

c) Justification: CAN YOU EXPLAIN WHY THERE ARE MORE ________ THAN THERE ARE __________?

S's response: ______________________________

______________________________

3) ARE THERE MORE CHILDREN OR MORE BOYS?

a) Response: ______________________________

b) Check: WHEN YOU SAY THERE ARE MORE __________ THAN __________, WHICH ARE THE __________ AND WHICH ARE THE __________?

S's response: ______________________________

c) Justification: CAN YOU EXPLAIN WHY THERE ARE MORE __________ THAN THERE ARE __________?

S's response: ______________________________

______________________________

4) ARE THERE MORE CHILDREN OR MORE GIRLS?

a) Response: ______________________________

b) Check: WHEN YOU SAY THERE ARE MORE __________ THAN __________, WHICH ARE THE __________ AND WHICH ARE THE __________?

S's response: ______________________________

c) Justification: CAN YOU EXPLAIN WHY THERE ARE MORE __________ THAN THERE ARE __________?

S's response: ______________________________

5) ARE THERE MORE CHILDREN OR MORE PEOPLE?

a) Response: ______________________________

b) Check: WHEN YOU SAY THERE ARE MORE __________ THAN __________, WHICH ARE THE __________ AND WHICH ARE THE __________?

S's response: ______________________________

c) Justification: CAN YOU EXPLAIN WHY THERE ARE MORE __________ THAN THERE ARE __________?

S's response: ______________________________

______________________________

# CLASS INCLUSION (Hierarchical Classification) - Task 2

Materials: 5 dog pictures, 4 cat pictures, 6 bird pictures

Procedure:

E shows S all the animals and says: HERE ARE SOME ANIMALS. THEY'RE ALL ANIMALS, BUT SOME OF THE ANIMALS ARE DOGS, SOME OF THE ANIMALS ARE CATS, AND SOME OF THE ANIMALS ARE BIRDS. LET'S SEE HOW MANY DOGS WE HAVE. FIRST, TAKE ALL THE DOGS OVER HERE AND COUNT THEM. (If S does not begin quickly to count, or counts incorrectly, E says: LET'S COUNT THEM TOGETHER, and helps S count.) When S finishes counting, E repeats, THAT'S RIGHT, THERE ARE FIVE DOGS IN THIS GROUP.

Next, E asks S to put all the cats next to the dogs in another group. NOW COUNT ALL THE CATS. (Again, assist S in counting, if needed.) Then say, THE DOGS AND THE CATS ARE ANIMALS WITH FUR. COUNT ALL THE ANIMALS WITH FUR. (Assist if needed.)

NOW, COUNT ALL THE BIRDS. (Assist if necessary.)

Place all the birds in a group next to the group of dogs and the group of cats, saying: WE HAVE FIVE DOGS, FOUR CATS, AND SIX BIRDS. HOW MANY ANIMALS DO WE HAVE?

Could count all the sub-groups and all the animals:

1a) counted dogs unassisted: yes _____ no _____
1b) counted cats unassisted: yes _____ no _____
1c) counted birds unassisted: yes _____ no _____
1d) counted animals unassisted: yes _____ no _____

When this task is completed, E mixes up the animals and asks:

2) ARE THERE MORE DOGS OR MORE ANIMALS?

a) Response: ______________________________

b) Check: WHEN YOU SAY THERE ARE MORE __________, WHICH ARE THE __________ AND WHICH ARE THE __________?

S's response: ______________________________

c) Justification: CAN YOU EXPLAIN WHY THERE ARE MORE __________ THAN THERE ARE __________?

S's response: ______________________________

______________________________

3) ARE THERE MORE ANIMALS WITH FUR (or: FURRY ANIMALS) OR MORE CATS?

a) Response: ____________________

b) Check: WHEN YOU SAY THERE ARE MORE ________ THAN ________, WHICH ARE THE ________ AND WHICH ARE THE ________?

S's response: ____________________

c) Justification: CAN YOU EXPLAIN WHY THERE ARE MORE ________ THAN THERE ARE ________?

S's response: ____________________

____________________

4) ARE THERE MORE FURRY ANIMALS OR MORE DOGS?

a) Response: ____________________

b) Check: WHEN YOU SAY THERE ARE MORE ________ THAN ________, WHICH ARE THE ________ AND WHICH ARE THE ________?

S's response: ____________________

c) Justification: CAN YOU EXPLAIN WHY THERE ARE MORE ________ THAN THERE ARE ________?

S's response: ____________________

____________________

5) ARE THERE MORE BIRDS OR MORE ANIMALS?

a) Response: ____________________

*b) Check: ____________________

c) Justification: ____________________

6) ARE THERE MORE FURRY ANIMALS OR MORE ANIMALS?

a) Response: ____________________

b) Check: ____________________

c) Justification: ____________________

* = ask same questions as above, recording responses.

Comments:

# MULTIPLE CLASSIFICATION
## Transfer Task #1

Materials: Red, yellow, and green diamonds, hearts, and crosses (9)

Explanation: E shows the shapes to S, identifying all the objects, with the help of S (LOOK AT ALL THESE SHAPES: WHAT ARE THESE (point to one)? THAT'S RIGHT: THEY'RE DIAMONDS. THE DIAMONDS ARE DIFFERENT COLORS, AREN'T THEY? WHAT COLORS DO YOU SEE?, etc.) E should make sure that S knows that there are three different shapes and three colors of each shape before going on to the task.

1) S could identify objects: all ________ none ________ some ______

2) S verbalized that some were different colors: yes ____ no ____

Procedure: E then shows S the matrix board, saying, HERE IS A BOARD WITH SOME SQUARES ON IT. WE ARE GOING TO PUT ALL THESE THINGS ON THE BOARD IN A SPECIAL WAY. I WANT YOU TO LOOK AT THESE THINGS, THEN PUT ONE OF THEM IN EACH SQUARE (THERE IS ONE SQUARE FOR EACH THING). I WANT YOU TO DO THIS SO THAT THE ROWS WILL GO TOGETHER IN A SPECIAL WAY, OR BE ALIKE SOMEHOW. REMEMBER, THERE IS A SPECIAL PLACE FOR EACH OF THESE SHAPES--SEE IF YOU CAN PUT EACH ONE IN ITS PLACE. TAKE YOUR TIME AND BE VERY CAREFUL. REMEMBER AS YOU DO THIS THAT YOU SHOULD HAVE A GOOD REASON FOR PUTTING THE SHAPES ON THE BOARD THE WAY YOU DO.

(If S fails to understand these directions, or just starts putting things on the board while you are still explaining it, E asks him/her to put one of the shapes on the board very carefully. E then asks S to find other things which might go with the first one in the row).

3) S needed help getting started: yes ______ no ______

4) Strategy used by S when starting task: a) random: __________ b) made grouping(s) first, then placed on board: ______________ c) put one at a time on board, looking for another one to go with it, seemed to be systematic in placing objects: ____________

Comments:

5) Items omitted:

6) Indicate the final placement of the items on the matrix board, using abbreviations: RD=red diamond, YC=yellow cross, etc.

Matrix Diagram(s)

Final placement during first attempt: (with board facing S)

| | | |
|---|---|---|
| | | |
| | | |

If random, or incomplete array is made, encourage S to try it another way, and remember to be very careful. Indicate second attempt below, if second attempt is necessary.

| | | |
|---|---|---|
| | | |
| | | |

MULTIPLE SERIATION
Transfer Task #2

Materials: Evergreen trees - three sizes and three shades of green

Explanation: E shows all the materials to S, identifying them with S's help, if possible. (LOOK AT THESE: DO YOU KNOW WHAT THEY ARE? THAT'S RIGHT, THEY'RE TREES. THE TREES ARE DIFFERENT, AREN'T THEY? WHAT MAKES THEM DIFFERENT? THAT'S RIGHT, SOME ARE BIGGER THAN OTHERS. IS THERE ANYTHING ELSE WHICH IS DIFFERENT ABOUT THESE TREES? YES, THEY ARE DIFFERENT SHADES OF GREEN [E will probably have to verbalize this for S]. SOME ARE LIGHTER AND SOME ARE DARKER.)

E should make sure that S knows that there are three different sizes and three different shades of green before going on to the task.

1) S could identify objects: yes ______ no ______

2) S verbalized some were bigger/smaller: yes ______ no ______

3) S verbalized some were lighter/darker: yes ______ no ______

other ______

Procedure: E then shows S the matrix board, saying, HERE IS A BOARD WITH SOME SQUARES ON IT. I WANT YOU TO PUT ALL THESE TREES ON THE BOARD IN A SPECIAL WAY. I WANT YOU TO LOOK VERY CAREFULLY AT THESE THINGS, THEN PUT ONE OF THE TREES IN EACH SQUARE (THERE IS ONE SQUARE FOR EACH TREE). I WANT YOU TO DO THIS SO THE ROWS WILL GO TOGETHER IN A SPECIAL WAY. REMEMBER, THERE IS A SPECIAL PLACE FOR EACH OF THESE TREES ON THE BOARD--SEE IF YOU CAN PUT EACH ONE IN ITS PLACE. TAKE YOUR TIME AND WORK VERY CAREFULLY, OK? REMEMBER AS YOU DO THIS THAT YOU SHOULD HAVE A GOOD REASON FOR PUTTING THE TREES ON THE BOARD THE WAY YOU DO.

(If S fails to understand these directions, or just starts putting trees on the board before directions are completed, E asks him/her to put one of the trees on the board, and then look carefully for another or others which might go with that one on the board.)

4) S needed help getting started: yes ______ no ______

5) Strategy used by S when starting task: a) random: ______________

b) made rows or groupings first, then placed on board: __________

c) put one tree at a time on the board, looking for others which differed or went with it somehow--seemed to be systematic in placing objects: ____________________

Comments:

6) Items omitted:

7) Indicate the final placement of the trees on the matrix board, using abbreviations such as: 1=small size, 2=medium size, 3=large size: L=light (green), M=medium, and D=dark, etc.

Use matrix on following page.

Matrix diagram(s)

Final placement during first attempt: (with board facing S)

| | | |
|---|---|---|
| | | |
| | | |

If random, or incomplete array is made, encourage S to try it another way, and remember to be very careful. Indicate second attempt below, if second attempt is necessary.

| | | |
|---|---|---|
| | | |
| | | |

CLASSIFICATION - PROBLEM SOLVING
Transfer Task #3

Materials: Picture cards of 4 kinds of wild animals, 7 pint fruit containers (cages).

Introduction: E shows S all the animal cards, making sure that S is familiar with all the animals. Then E says: WE'RE GOING TO PRETEND THAT YOU ARE A ZOO KEEPER, AND THESE ARE THE ANIMALS IN YOUR ZOO. IT WILL BE YOUR JOB TO PUT THEM IN THEIR CAGES AND TAKE CARE OF THEM IN A LITTLE BIT, BUT YOU MUST BE VERY CAREFUL TO KEEP THE SAME KIND OF ANIMAL TOGETHER (IN THE SAME CAGE) AND NOT MIX THEM UP. WHEN YOU PUT DIFFERENT KINDS OF ANIMALS TOGETHER IN THE SAME CAGE THEY FIGHT AND COULD REALLY HURT EACH OTHER.

Problem: THE PROBLEM THAT YOU HAVE TO SOLVE NOW, ZOO KEEPER, IS HOW MANY CAGES YOU WILL NEED. REMEMBER, YOU HAVE TO PUT ONLY ANIMALS WHICH ARE ALIKE TOGETHER. YOU CAN DO WHATEVER YOU NEED TO DO TO FIGURE OUT HOW MANY CAGES YOU WILL NEED IN YOUR ZOO. WORK CAREFULLY, AND TAKE YOUR TIME. WHEN YOU THINK YOU KNOW HOW MANY CAGES YOU WILL NEED, TELL ME.

1) Answer given: correct ______ incorrect ______ (If incorrect, answer S gave ______

2) Strategy employed: a) classified animals first ________
classified all ______, some ________
b) appeared to guess ________
c) other (describe):

After S has answered, E asks: HOW DID YOU KNOW THAT YOU WOULD NEED ________ CAGES IN YOUR ZOO?

3) S's response:

If S hasn't already put the animals in their cages, E encourages him/her to do this and check their answer.

SERIATION PROBLEM
Transfer Task #4

Materials: 5 seriated snow-people and 5 seriated hats, various colors

Preparation: E shows S the snow-people or snowmen, saying, HERE ARE SOME SNOW PEOPLE, then shows S the hats (which are also in random order) saying, HERE ARE SOME HATS FOR THE SNOW PEOPLE.

Task: E then says, I WANT YOU TO FIND OUT WHICH SNOW PERSON (SNOWMAN, if child calls it that) THE YELLOW HAT BELONGS TO. YOU CAN DO WHATEVER YOU NEED TO DO TO FIND OUT WHICH SNOWMAN GOES WITH THE YELLOW HAT.

1) Snow-person selected was: correct ________ incorrect ________

If incorrect, number snowman selected ________ (see back for no.)

2) Strategy used: random (guess) ________

the seriated snow-people ________, the hats ______

Other:

Then E says, NOW I WANT YOU TO FIND OUT WHICH SNOW PERSON THE GREEN HAT BELONGS TO.

3) Strategy used: random ________

seriated snow-people ________ seriated hats ______

Other:

4) Correct ________ If incorrect, which number snow-person was selected ________

Finally, E says, pointing to snow-person #3, WHAT COLOR HAT BELONGS TO THIS SNOWPERSON? DO WHATEVER YOU NEED TO DO TO FIND THE RIGHT HAT FOR THIS ONE.

5) Correct ________ If incorrect, no. (or color) hat selected ______

6) Strategy: random ________ seriated hats ________ snowmen ________

Comments:

CONSERVATION OF AREA
Posttest Transfer #5

Materials: ______ FIELDS/LADYBUGS ______

(Materials are two green-colored boards to represent fields. There are equal area ladybugs. Each ladybug measures 30 cm x 20 cm.)

IDENTITY

E displays one field and places 3 ladybugs in a line across one edge of the field. E says, THIS IS A FIELD WITH LOTS OF LADYBUGS ON IT. PART OF THE FIELD IS NOT COVERED BY THE LADYBUGS (pointing). E then scatters the ladybugs randomly on the fields and asks the following questions in random order:

_____ CAN YOU STILL SEE THE SAME AMOUNT OF FIELD AS YOU COULD SEE BEFORE?

(a) Yes _____ No _____ No Response _____ I don't know _____

(b) Justification (HOW DO YOU KNOW? or HOW COULD YOU TELL?)

_______________________________________________

_____ CAN YOU SEE MORE OF THE FIELD NOW?

(a) Yes _____ No _____ No Response _____ I don't know _____

(b) Justification

_______________________________________________

_____ CAN YOU SEE LESS OF THE FIELD NOW?

(a) Yes _____ No _____ No Response _____ I don't know _____

(b) Justification

_______________________________________________

EQUIVALENCE: FIELDS AND LADYBUGS

E presents the two 30 cm x 20 cm fields and shows their equivalence by superimposing them. After S agrees that there is the same amount of grass on each field, E says, WE ARE PUTTING A LADYBUG ON THIS FIELD. NOW POINT TO THE FIELD WHICH HAS THE MOST GRASS SHOWING. YES (or NO), THAT FIELD HAS THE MOST GRASS SHOWING. NOW WE ARE PUT-

TING A LADYBUG ON THE OTHER FIELD. NOW DO BOTH THE FIELDS HAVE THE SAME AMOUNT OF GRASS SHOWING? (Both ladybugs are placed in the upper right hand section of the table). YES, BOTH FIELDS HAVE THE SAME AMOUNT OF GRASS SHOWING.

Part A.

E says, WATCH WHAT I DO. YOU SEE. I AM PUTTING SOME LADYBUGS ON EACH FIELD. (E places three ladybugs next to each other down one side of one of the fields. Three ladybugs are randomly placed on the other field.) E asks the following questions in a random order:

______ DO YOU SEE THE SAME AMOUNT OF GRASS ON THIS FIELD AS ON THAT FIELD?

(a) Yes _____ No _____ No Response _____ I don't know _____

(b) Justification: ______________________________

______ DOES THIS FIELD (ladybugs in a row) HAVE MORE GRASS SHOWING THAN THIS ONE (ladybugs randomly distributed)?

(a) Yes _____ No _____ No Response _____ I don't know _____

(b) Justification: ______________________________

______ DOES THIS FIELD (ladybugs scattered) HAVE MORE GRASS SHOWING THAN THIS ONE (ladybugs in a row)?

(a) Yes _____ No _____ No Response _____ I don't know _____

(b) Justification: ______________________________

If S gets these wrong, repeat problem (see following section), scrambling the materials.

Part B. FIELDS AND LADYBUGS

E removes ladybugs from both fields and says, NOW WE ARE GOING TO PUT SOME MORE LADYBUGS ON THESE FIELDS. I AM GOING TO PUT ONE LADYBUG ON THIS FIELD, AND NOW I SHALL PUT A LADYBUG ON THIS FIELD. EVERYTIME I PUT A LADYBUG ON THIS FIELD I SHALL ALSO PUT A LADYBUG ON THIS FIELD. (E places 3 ladybugs in a line down the side of one field and 3 ladybugs scattered on the other field. E then asks the following questions in a random order:)

_____ CAN YOU SEE AS MUCH GRASS ON THIS FIELD AS THAT ONE?

(a) Yes _____ No _____ No Response _____ I don't know _____

(b) Justification

_______________________________________________

_____ DOES THIS FIELD (ladybugs in a row) HAVE MORE GRASS SHOWING THAN THIS ONE (ladybugs scattered)?

(a) Yes _____ No _____ No Response _____ I don't know _____

(b) Justification

_______________________________________________

_____ DOES THIS FIELD (ladybugs scattered) HAVE MORE GRASS SHOWING THAN THIS ONE (ladybugs in a row)?

(a) Yes _____ No _____ No Response _____ I don't know _____

(b) Justification

_______________________________________________

CONSERVATION OF NUMBER
Transfer Task #6

Materials: 12 pennies (8 for warm-up, 12 for tasks)

Warm-up

E constructs two parallel rows of evenly spaced pennies (6 pennies in the row closest to E, 2 pennies in the row closest to S) and asks:

DO THE TWO ROWS HAVE THE SAME NUMBER OF PENNIES?

Yes No No Response

WHICH ROW HAS MORE PENNIES?

Correct Incorrect No Response

Equivalence

Parts (A) and (B) are Counterbalanced

(A) Expansion

E constructs two parallel rows (6 pennies per row) of evenly spaced pennies in the center of the table, making precise perceptual correspondence (:::::::) between the elements of the two rows. E discusses how the rows have the same number of pennies. After S has agreed that they have the same number of pennies, E expands the row nearest to E. (. . ˙:˙:˙:˙ .)

E then asks the following (randomly ordered) questions:

______ DOES THIS ROW HAVE JUST AS MANY (THE SAME NUMBER OF) PENNIES AS THIS ROW?

(a) Yes _____ No _____ No Response _____ I don't know _____

(b) *Justification:

1. HOW DO YOU KNOW THAT? or HOW COULD YOU TELL?

______________________________

2. If S says "no," E asks, HOW COULD YOU MAKE IT SO THEY HAVE THE SAME NUMBER? or COULD YOU DO SOMETHING TO MAKE BOTH ROWS HAVE THE SAME NUMBER? ______________

______________________________

______ DOES THIS ROW (long one) HAVE MORE PENNIES?

(a) Yes ______ No ______ No Response ______ I don't know ______

(b) Justification:

1. ______________________________

2. (If S says "yes" . . .) ______________________________

______ DOES THIS ROW (short one) HAVE MORE PENNIES?

(a) Yes ______ No ______ No Response ______ I don't know ______

(b) Justification:

1. ______________________________

2. (If S says "yes" . . .) ______________________________

*After S has given an adequate justification, E does not request justifications for subsequent questions. The second part of the justification is asked only once--the first time S gives a wrong answer.

(B) Pennies in a Heap

E reestablishes equivalence with S and then repeats procedure in (A) except one row of pennies is piled in a heap.

______ ARE THERE JUST AS MANY (THE SAME NUMBER OF) PENNIES HERE (row) AS THERE ARE HERE (heap)?

(a) Yes ______ No ______ No Response ______

(b) *Justification:

1. ______________________________

2. (If S says "no," E asks, HOW COULD YOU MAKE IT SO THEY HAVE THE SAME NUMBER? or COULD YOU DO SOMETHING TO MAKE BOTH ROWS HAVE THE SAME NUMBER?)

______ ARE THERE MORE PENNIES HERE (row)?

(a) Yes ______ No ______ No Response ______

(b) Justification:

1. ____________________

2. (If S says "yes" . . .) ____________________

______ ARE THERE MORE PENNIES HERE (heap)?

(a) Yes ______ No ______ No Response ______

(b) Justification:

1. ____________________

2. (If S says "yes" . . .) ____________________

APPENDIX B

FOUR TYPES OF ADVANCE ORGANIZER LESSONS

AND RATING SHEETS

CLASSIFICATION #1

E: WE'RE GOING TO BE TALKING ABOUT A LOT OF THINGS TODAY, AND ANOTHER WORD FOR THINGS IS OBJECTS. CAN YOU SAY THAT WORD?

Ss: Objects

E: THERE ARE ALOT OF OBJECTS IN THIS ROOM. LET'S SEE--CHRISTOPHER, CAN YOU SPOT AN OBJECT IN THIS ROOM?

C: Trucks (points to some of materials on high table)

E: THERE WERE SOME TRUCKS YOU SAW, AND TRUCKS ARE KINDS OF OBJECTS, RIGHT. HOW ABOUT YOU, BRIAN, CAN YOU SPOT ANY OBJECTS IN THIS ROOM?

B: Chairs

E: THERE'S LOTS OF THOSE OBJECTS--A BUNCH OF CHAIRS IN HERE. AND HOW ABOUT YOU TODD? WHAT'S ANOTHER OBJECT IN THIS ROOM?

T: A box

E: A BOX; LIKE THE ONE I BROUGHT ALL MY STUFF OR MY OBJECTS IN. AND HOW ABOUT YOU, BRAD, DO YOU SEE ANY MORE OBJECTS IN THIS ROOM?

B: Chairs (others whisper table) Table

E: HOW ABOUT (points to clothes) THIS STUFF?

Ss: Clothes, pants

E: YES, CLOTHES ARE OBJECTS; CHAIRS AND TABLES (S: I said chairs). ALL THOSE THINGS ARE OBJECTS. AND THERE ARE CERTAIN THINGS THAT WE CAN KNOW ABOUT OBJECTS, CALLED THEIR PROPERTIES. AND ONE OF THE THINGS WE CAN KNOW ABOUT THEM (OR ONE OF THEIR PROPERTIES) IS THEIR COLOR, RIGHT?

Ss: Yeah, right

E: LOOK AT THE CHAIRS IN THIS ROOM--WHAT COLOR ARE MOST OF THE CHAIRS?

S: Silver or brown?

E: RIGHT; WHAT COLOR ARE BRAD'S PANTS? (green) AND HOW ABOUT HIS SWEATER? (green) AND WHAT COLOR IS BRIAN'S SWEATER? (blue and red). SO ONE OF THE THINGS WE CAN MEASURE ABOUT OBJECTS IS COLOR--THINGS HAVE SPECIAL COLORS. ANOTHER THING WE CAN MEASURE IS SIZE. WE CAN MEASURE USING THINGS LIKE THIS (brings out tape measure). HAVE YOU EVER USED ONE OF THESE?

Ss: I used it (etc.)

E: SINCE PEOPLE ARE SORT OF OBJECTS OR THINGS WE COULD MEASURE HOW TALL SOMEBOBY IS OR HOW LONG ANOTHER KIND OF OBJECT IS. LET'S MEASURE BRAD AND LOOK AT THE PROPERTY OF HEIGHT, OR HOW TALL HE IS. HE IS 46" TALL. I SAW A CHART IN THE ROOM WHERE YOU'D ALL MEASURED HOW TALL YOU WERE.

YOU CAN ALSO MEASURE HOW HEAVY THINGS ARE. FEEL THESE WEIGHTS. (they do) THEY'RE NOT ALL THE SAME--THEY ARE DIFFERENT WEIGHTS OR WEIGH DIFFERENT AMOUNTS. JUST LIKE OBJECTS HAVE DIFFERENT COLORS AND DIFFERENT HEIGHTS, THEY ALSO HAVE DIFFERENT WEIGHTS. AND THESE WEIGHTS ARE OBJECTS, AREN'T THEY?

Ss: Yup

E: RIGHT

E: YOU CAN EVEN MEASURE HOW HEAVY YOU ARE, BY GETTING ON THE SCALES. THE SCALES MEASURE THE PROPERTY OF WEIGHT, OR HOW HEAVY. (E weighs all Ss, comparing them) ANOTHER WAY TO MEASURE IS TO COUNT. WE CAN COUNT HOW MANY OBJECTS. HERE ARE SOME CARDS WITH DOTS ON THEM. HOW MANY GREEN DOTS ON THAT CARD?

Ss: One

E: HOW MANY DOTS ON THIS CARD (points)

Ss: Two

E: AND ON THIS ONE?

Ss: Three (one of them points to last card) four

E: THAT'S VERY GOOD!, SO, ONE OF THE THINGS YOU CAN MEASURE ABOUT OBJECTS IS HOW MANY. WE CAN MEASURE IN ALOT OF WAYS. SO FAR WE'VE SEEN WE CAN MEASURE BY COUNTING, BY WEIGHING, BY MEASURING HOW LONG OR WIDE--HOW ABOUT MEASURING BY TASTING? DID YOU KNOW WE COULD DO THAT?

Ss: No!!

E: DON'T YOU THINK SO? WELL, TRY THIS. HERE ARE SOME CUPS WITH DIFFERENT THINGS TO TASTE IN THEM. YOU WILL NEED TO WET YOUR FINGER A LITTLE BIT, THEN PUT IT IN THIS CUP (with sugar) AND GET A LITTLE TASTE. DOES THIS TASTE SWEET TO YOU, OR SOUR, OR HOW?

Ss: Sweet--that's like sugar

E: THAT'S RIGHT--IT TASTES SWEET BECAUSE IT'S SUGAR. YOU DIDN'T SEE A SIGN ON THIS CUP THAT SAID SUGAR, DID YOU? (Ss: no!) AND STILL YOU KNEW HOW IT TASTED, AND COULD EVEN GUESS WHAT IT WAS. YOU MEASURED WITH YOUR--

Ss: Tongue E: RIGHT--YOU USED YOUR TONGUE AND MOUTH TO MEASURE

E: (points to other cup) THIS STUFF MIGHT NOT TASTE SO GOOD, SO YOU DON'T HAVE TO TRY IT--BUT IF YOU DID, IT WOULD TASTE VERY DIFFERENT, BECAUSE IT'S FLOUR.

Ss: Ick!! ohh (one tastes it)

E: HOW DOES IT TASTE? IT'S VERY DIFFERENT FROM THE SUGAR ISN'T IT?

S: Yes--I want some more sugar.

E: HERE YOU GO; SO WE'VE JUST TALKED ABOUT SOME OF THE WAYS TO MEASURE (listened to jars for matching sounds) AND WE ALSO TALKED ABOUT OBJECTS. YOU KNOW THERE ARE SO MANY OBJECTS OR THINGS ALL AROUND US, THAT WE HAVE TO HAVE SPECIAL WAYS TO THINK ABOUT THEM AND REMEMBER THEM.

ONE WAY IS TO PUT THINGS THAT ARE ALIKE IN SOME WAY, OR ARE THE SAME, INTO GROUPS. WE'LL BE TALKING ALOT NOW ABOUT MAKING GROUPS OF THINGS WHICH ARE ALIKE IN SOME WAY.

FIRST, LET'S BE SURE WE KNOW WHAT BEING ALIKE OR THE SAME MEANS.

Ss: What

E: HIS SWEATER IS (points)--

Ss: red E: AND HIS SWEATER IS Ss: red E: SO THEIR SWEATERS ARE THE SAME--RIGHT TODD?

T: Right

E: AND BRAD'S PANTS ARE GREEN AND SO ARE BRIAN'S--RIGHT, CHRISTOPHER?

C: Right

E: NOW, BRAD'S PANTS ARE GREEN AND TODD'S SWEATER IS RED, SO THEY ARE NOT THE SAME; THEY ARE DIFFERENT, RIGHT?

Ss: Yup, right, yeah

E: SO, WHEN THINGS OR OBJECTS HAVE THE SAME PROPERTY WE CAN MEASURE--LIKE THE SAME COLOR OR TASTE, WE CAN PUT THEM TOGETHER BECAUSE THEY ARE THE SAME.

(E gets out the plastic bears)

HERE ARE SOME LITTLE BEARS--THEY ARE THE SAME IN THAT WAY--THEY'RE ALL LITTLE, BABY BEARS. THE BEARS ARE ALL THE SAME SIZE, TOO, AREN'T THEY?

Ss: Yup, guess so

E: BUT THE BEARS ARE ALSO DIFFERENT IN SOME WAY--THEY ARE DIFFERENT COLORS.

C: Some of the bears are blue and some of the bears are red, right?

E: RIGHT, CHRISTOPHER! NOW, WE CAN MAKE SOME GROUPS OF BEARS WHICH ARE ALIKE BY COLOR. WE CAN MAKE A GROUP OF ALL THE BLUE BEARS (BRIAN--WILL YOU PUT ALL THE BLUE BEARS IN A GROUP?)

B: O.K.

E: NOW, BRIAN, BE SURE TO PUT EVERY BLUE BEAR IN YOUR GROUP AND NOT LEAVE ANY OUT--DID YOU DO THAT?

B: Yes--that's all of 'em

E: NOW, TODD, CAN YOU MAKE A GROUP USING ALL THE RED BEARS? BE CAREFUL TO PUT ALL THE RED BEARS IN YOUR GROUP AND NOT LEAVE ANY OUT!

T: There--done!

E: NOW MAKE SURE THAT ALL THE BEARS IN YOUR GROUP ARE RED--ARE THEY?

T: Think so--yeah (E scrambles bears again)

E: GOOD! NOW, I'LL TELL YOU AGAIN HOW TO MAKE GROUPS, OK? FIRST YOU HAVE TO LOOK AT ALL THE OBJECTS--HERE IT'LL BE THE BEARS. LOOK AT ALL THE BEARS. ARE YOU LOOKING AT THEM?

Ss: Yes, o.k.

E: NEXT WE LOOK FOR A PROPERTY THAT SOME OF THEM SHARE--IN THIS CASE, A COLOR THEY SHARE. LET'S SAY WE SEE THAT SOME OF THE BEARS ARE BLUE, O.K?

Ss: O.K.

E: NOW PUT A BLUE BEAR OVER HERE AND FIND ALL THE OTHER BEARS WHICH ARE LIKE IT--OR BLUE--AND PUT THEM WITH THIS BEAR TO MAKE A BLUE GROUP. BE CAREFUL TO PUT ONLY BLUE BEARS IN THIS GROUP. ALSO BE SURE THAT YOU PUT ALL THE BLUE BEARS IN THIS GROUP AND

DON'T LEAVE ANY OUT. (E finishes group)

E: NOW, LOOK AT THE BEARS WHICH ARE LEFT--THEY'RE ALREADY IN A GROUP, AREN'T THEY?

Ss: Yup

E: THEY'RE ALL RED BEARS, SO THEY'RE THE RED GROUP, RIGHT?

Ss: Right, yeah

E: (gets out mice--same colors) HERE ARE SOME MICE TO ADD TO OUR BEARS. THEY ARE ALL MICE, BUT SOME OF THEM ARE DIFFERENT COLORS.

C: They're red and blue, too!

B: Look at the mouses!

C: I know--we can put all the mice in a group and all the bears in a group.

E: RIGHT, CHRISTOPHER! THE MICE ARE DIFFERENT SHAPED THAN THE BEARS. NOW WE CAN SCRAMBLE ALL OUR OBJECTS TOGETHER--ALL THE MICE AND ALL THE BEARS--AND WE CAN MAKE NEW GROUPS. FIRST, LET'S MAKE GROUPS BY WHAT KIND OF ANIMAL THEY ARE. BRIAN, CAN YOU MAKE A GROUP USING ALL THE MICE--NO MATTER WHAT COLOR THEY ARE?

B: Sure--these mice are mine--little meecey, micey, mousy (while grouping)

E: NOW, DID BRIAN PUT EVERY MOUSE IN HIS GROUP AND NOT LEAVE ANY OUT? AND DID HE MAKE SURE THAT EVERY ANIMAL IN HIS GROUP WAS A MOUSE?

Ss: Yep, yup

E: GOOD! SO BRIAN MADE A GROUP OF MICE. NOW, TODD, CAN YOU MAKE A GROUP OF ALL THE BEARS--NO MATTER WHAT COLOR THEY ARE?

T: O.K. (does so, rather slowly)

E: LOOK AT THESE TWO GROUPS--ONE HAS ALL THE MICE IN IT AND THE OTHER HAS ALL THE BEARS. GEE, TODD, THOSE ARE LINED UP SO NICE I HATE TO MESS UP YOUR ROW, BUT I WANT TO SCRAMBLE THEM ALL UP AGAIN AND MAKE A BIG GROUP OF ALL THE PLASTIC ANIMALS, OK?

T: Well, O.K. here

E: SEE--ALL THESE PLASTIC ANIMALS ARE TOYS, RIGHT?

Ss: Yup, right

E: NOW, LET'S MAKE DIFFERENT GROUPS THAN LAST TIME. THIS TIME LET'S DO IT BY COLOR, RATHER THAN BY SHAPE.

THIS TIME IT WON'T MATTER WHETHER AN OBJECT OR ANIMAL IS A BEAR OR A MOUSE, ONLY THE COLOR WILL MATTER. CHRISTOPHER--CAN YOU MAKE A GROUP USING ALL THE RED OBJECTS? BE SURE TO PUT EVERYTHING THAT'S RED INTO YOUR GROUP AND NOT ANY BLUE THINGS, OK?

C: o.k.--here's the group (hands it to Brian, saying:) Brian you can take care of these things for me

E: GOOD--NOW BRAD, CAN YOU MAKE A GROUP OF ALL THE BLUE THINGS--REMEMBER WE'RE JUST MAKING THESE GROUPS BY COLOR, NOTHING ELSE.

B: O.K.--how's that one?

E: FINE! SO WE MADE TWO DIFFERENT KINDS OF GROUPS FROM THESE SAME OBJECTS DIDN'T WE? FIRST, WE MADE GROUPS BY SHAPE OR WHAT KIND OF ANIMAL AND SECOND OR LAST WE MADE GROUPS BY COLOR. AND WE COULD SAY THAT WHEN WE PUT ALL OUR THINGS BACK INTO ONE BIG GROUP THAT ALL THE THINGS WERE PLASTIC ANIMALS, RIGHT?

Ss: Right! yup

E: (gets out hooks or "anchors" same colors) HERE ARE SOME MORE PLASTIC OBJECTS. SHOULD WE CALL THEM HOOKS OR ANCHORS?

Ss: Anchors, anchors

E: OK, SO WE CAN PUT THESE ANCHORS WITH ALL THE OTHER OBJECTS AND CALL THE GROUP WE MAKE PLASTIC THINGS OR PLASTIC TOYS. NOW, WE CAN MAKE MORE GROUPS LIKE WE'VE BEEN DOING. SHALL WE DO IT BY COLOR FIRST?

Ss: OK T: Let me do it first!

E: OK, TODD, CAN YOU PUT ALL THE BLUE THINGS INTO ONE BIG GROUP? REMEMBER, IT DOESN'T MATTER WHETHER THEY'RE ANCHORS OR BEARS OR MICE--IT ONLY MATTERS IF THEY ARE BLUE.

C: Here, let me help you, Todd--you need this one too--he was going to leave all the mice out.

E: NOW, DOES IT LOOK LIKE HE HAS EVERY BLUE OBJECT IN HIS GROUP?

Ss: Yup, guess so

E: AND ARE ALL THE THINGS IN HIS GROUP BLUE?

Ss: Yes B: Sure!

E: NOW LOOK AT THE OBJECTS THAT ARE LEFT--BRAD, CAN YOU PUT ALL THE RED THINGS TOGETHER INTO ANOTHER BIG GROUP?

B: Here--they're already like that, see?

E: SO, ALL THESE THINGS ARE TOGETHER (points) BECAUSE THEY'RE BLUE. AND ALL THESE THINGS ARE TOGETHER BECAUSE THEY'RE RED. NOW, LET'S SCRAMBLE THEM ALL UP AGAIN INTO OUR BIG GROUP OF PLASTIC TOYS, OK?

Ss: Can we just play with them?

E: SURE, WHEN WE'RE DONE MAKING GROUPS YOU CAN JUST PLAY FOR AWHILE. NOW, LET'S SEE IF THERE'S ANOTHER WAY WE CAN MAKE GROUPS USING THESE SAME OBJECTS. HOW ABOUT BY SHAPES AGAIN? CHRISTOPHER, CAN YOU MAKE A GROUP OF ALL THE ANCHORS? WHILE HE'S DOING THAT, BRIAN, CAN YOU PUT ALL THE MICE INTO A GROUP? YOU CAN HELP EACH OTHER FIND EVERYTHING YOU NEED, MAYBE.

(each does this well).

E: VERY GOOD! NOW THERE ARE THREE DIFFERENT GROUPS WITH OUR SAME PLASTIC TOYS. A GROUP OF ALL THE BEARS, A GROUP OF ALL THE MICE, AND ONE WITH ALL THE ANCHORS.
(E puts these away and brings out plastic dishes).

E: HERE ARE SOME DISHES--WE COULD PRETEND THIS IS A PICNIC, OK?

Ss: Good, yummy, let's go, it's too cold!

E: NOW, ALL THESE OBJECTS ARE PLASTIC DISHES, RIGHT? EVERY ONE?

Ss: Yup, right

E: BUT THERE ARE DIFFERENT KINDS OF DISHES HERE--THEY'RE NOT ALL THE SAME KIND, ARE THEY? LET'S SEE IF WE CAN MAKE GROUPS OF THESE DISHES BY SHAPE. TODD, CAN YOU PUT ALL THE PLATES IN A PILE? CHRIS--CAN YOU PUT ALL THE BOWLS TOGETHER, AND BRIAN, ALL THE CUPS? (they do so)

E: OH, THOSE ARE GOOD GROUPS! NOW WE CAN GIVE THESE DIFFERENT GROUPS NAMES, CAN'T WE--NAMES THAT TELL US WHAT'S IN THESE DIFFERENT GROUPS. YOUR'S ARE WHAT, BRIAN?

B: All the cups

E: AND WHAT ABOUT THE THINGS IN YOUR GROUP TODD?

T: The bowls, I mean--(C: your's are the plates Todd!) oh--the plates, OK

E: AND YOUR'S CHRIS?

C: All the bowls in here

E: (collects dishes) NOW WE'LL BE MAKING GROUPS WITH LOTS OF MATERIALS WHEN I COME BACK, BUT THE LAST THING WE'LL MAKE GROUPS WITH TODAY IS M&Ms, OK?

Ss: oh boy--good, umm, can we eat 'em?

E: AFTER WE'VE MADE GROUPS BY DIFFERENT COLOR YOU CAN EAT THEM--OR IS IT TOO EARLY IN THE MORNING TO EAT CANDY?

Ss: No, no

B: I like to play with the M&Ms, but I won't play with that shark back in the room!

(all Ss grouped by color and named their groups correctly)

CLASSIFICATION #2

E: WHO CAN NAME SOME THINGS THAT THEY SEE IN THE ROOM?

Ss: Nothing

E: WHAT'S SOMETHING YOU SEE IN THE ROOM? CAN YOU NAME SOMETHING WHEN YOU SEE SOMETHING?

S: Nothing (Tommy, faintly: a light)

E: WHAT DO YOU SEE TOMMY?

T: A light

E: WHAT DO YOU SEE MIKE?

M: Nothing

E: WHAT DO YOU SEE DOUG?

D: A chair

E: KATY--WHAT DO YOU SEE IN THE ROOM?

K: (laughing) nothing!

E: I SEE A FEW THINGS IN HERE--SOME KIDS, TABLES, CHAIRS, A PROJECTOR--

M: Hey, we got a projector but the light burnt out, and we got a new one, then mom had to bring it back to the library and we showed cartoons

E: OH, YOU SAW CARTOONS AT HOME? THAT'S NEAT! SO, I SEE ALOT OF THINGS IN THE ROOM; DO YOU KNOW WHAT IT MEANS WHEN THINGS ARE THE SAME?

Ss: Huh uh I dunno

E: LET'S SEE--WHAT ABOUT THOSE CHAIRS--DO YOU THINK THE CHAIRS ARE ALIKE OR THE SAME IN SOME WAY?

M: Nothing D: same wood

E: DOUG SAID THEY HAVE THE SAME WOOD. WHAT ABOUT COLOR?

D: Some are same color

E: (points to M's shirt and vest, which were different colors) IS HIS SHIRT THE SAME COLOR AS HIS VEST?

Ss: No

E: WHAT COLOR IS HIS SHIRT?

Ss: Blue my nametag matches my shirt!

E: YES, YOU'RE IN THE BLUE GROUP, SO IT LOOKS LIKE YOUR SHIRT MATCHES YOUR NAME TAG. AND WHAT COLOR IS HIS VEST? (points)

Ss: Red

E: HMMM. SO DO YOU THINK HIS VEST AND SHIRT ARE THE SAME COLOR OR DIFFERENT COLORS?

Ss: Different, dunno D: and mine are the same

E: MOST OF YOU HAVE SOME BLUE ON, DON'T YOU?

Ss: Yup I match me too

E: WHEN YOU MATCH LIKE THAT DO YOU THINK YOU'RE THE SAME OR ARE YOU DIFFERENT?

Ss: Same same I match you too

E: (brings out tape measure) DO YOU KNOW WHAT THIS IS?

Ss: String, measure thing

E: DO YOU KNOW WHAT WE CAN USE IT FOR?

Ss: Hold it up to me--I'm bigger than everybody

E: SO YOU WANT ME TO HOLD IT TO YOU LIKE THIS (measures his height)?

S: Yup--see how tall I am?

E: SO, WE CAN USE THIS TO MEASURE HOW TALL YOU ARE, RIGHT?

Ss: Yup, yes, me too it's my turn--I'm tallest one (etc.)

E: (after measuring all kids) ARE YOU GUYS ALL THE SAME HEIGHT OR ARE YOU DIFFERENT HEIGHTS?

Ss: Same no, biggest different I'm so tall

E: (brings out cups with flour, sugar)

Ss: What's those? something to eat?

E: DO YOU WANT TO TASTE THESE AND SEE IF YOU CAN TELL WHAT THEY ARE?

Ss: Yummy, what's this one?

E: MAYBE YOU CAN TASTE THIS ONE FIRST AND GUESS WHAT IT IS? (hands them sugar)

Ss: Umm good I can tell it's sugar--it looks like sugar

E: DO YOU THINK YOU COULD TELL IT WAS SUGAR IF YOU COULDN'T SEE IT?

K: No B: Sure, I could it's so good it's sweet like sugar

E: AND WHAT ABOUT THIS ONE (flour)?

Ss: Ick! it's icky

E: CAN YOU GUESS WHAT IT IS?

Ss: Salt? no, what? not sugar? Is it flour? oh, yeah flour for dough, right?

(gets out scale)

E: WHAT'S THIS--DO YOU KNOW?

Ss: Scales dunno

E: WHAT CAN YOU TELL FROM STANDING ON THIS?

Ss: How much you weigh, right?

(E weighs all Ss)

E: (gets out jars with different things in)

Ss: What are those for?

E: CAN YOU LISTEN TO THEM? SHAKE ONE AT A TIME, MAYBE? DO ANY OF THEM SOUND THE SAME? CAN YOU FIND TWO THAT ARE JUST ALIKE, OR NOT?

Ss: try it--some trouble with it--want to take lids off, etc. K finds two that sound alike

E: NOW LET'S TAKE THE LIDS OFF THESE TWO AND SEE IF SHE COULD TELL THAT THEY WERE ALIKE. LOOK--WHAT DO THEY BOTH HAVE IN THEM?

Ss: Beans! Can we eat them?

E: NO--THEY'RE DIRTY BY NOW--AND VERY HARD, NOT COOKED OR ANYTHING, DON'T YOU THINK THEY'D BE BAD?

Ss: No well, maybe look dirty too

E: WHAT DID YOU USE TO FIGURE OUT WHICH TWO WERE THE SAME, KATY?

K: I dunno--just knew it

E: DID YOU USE YOUR MOUTH, YOUR HANDS, YOUR (points to ears)

K: Used my ears to know it

E: (puts these away and brings out bears) WHAT ARE THESE THINGS, DO YOU THINK?

Ss: Bears no dunno

E: ARE THEY ALL BEARS? ARE THEY ALL THE SAME SOMEHOW?

Ss: No--they're camels (laughter)

E: IS THERE A WAY THEY'RE ALL ALIKE?

Ss: (M: no K: no T: bears--all bears others: no!)

E: ARE THEY ALL BEARS?

K and T: There's camels! K: They're zebras!!

E: LET'S CALL 'EM CAMELS, OK?

Ss: No, some are bears

E: WELL, SHALL WE CALL THEM BEARS? HOW ABOUT YOU--CAMEL GUYS, IS BEARS OK?

Ss: OK that's allright

D: Uh, I want to call 'em camels

E: OK, YOU CAN CALL THEM CAMELS, NOW, ARE THEY ALL BEARS (to E, all-
D: (interrupts E) no there all camels

E: OK, FOR DOUG, ARE THEY ALL CAMELS?

Others Ss: no all bears

E: ARE THEY ALL ANIMALS OR NOT?

Ss: Yup these are animals

E: OK, SO YOU THINK THEY ARE ALL ANIMALS--ARE THEY THE SAME THEN?

Ss: Yup maybe

E: HOW ARE THESE ANIMALS DIFFERENT--CAN YOU TELL?

Ss: I don't know, oink, oink how are they?

E: ARE THEY DIFFERENT SIZES?

Ss: no, no, yucky (Katy puts bears in back of her)

E: LET'S SEE KATY'S BEARS, OK?

K: I got none--no bears T: there they are--show us your bears, aren't you playing this game, silly?

K: brings out bears--Well here you go

E: THANKS, KATY. ARE ALL THESE LITTLE BEARS THE SAME COLOR--WHAT DO YOU THINK?

Ss: No--some blue some of them are red

E: OK--(points to a red one) WHAT COLOR IS THIS ONE?

Ss: red (M: no--purple)

E: MOST OF YOU THINK IT'S RED?

Ss: Yup, yes, it's red

E: CAN YOU FIND ANY MORE BEARS THAT ARE LIKE THIS ONE SOMEHOW?

K: Here's another red one, and another one, bunch of red ones, right?

E: HMM--CAN YOU PUT THOSE REDS TOGETHER SOMEHOW? HOW WOULD YOU DO THAT?

T: In my hand like this (also has blue ones in hand, though)

E: CAN YOU LOOK AT ALL THOSE BEARS IN YOUR HAND AND SEE IF THEY'RE ALL THE SAME OR NOT?

K: Look, Tommy--give me those blue ones you don't need 'em yet

E: WHY DOESN'T HE NEED THE BLUE BEARS?

K: I dunno he just doesn't now

E: NOW THAT KATY TOOK AWAY THE BLUE ONES, TOMMY--WHAT COLOR ARE ALL THE BEARS IN YOUR HAND? DO YOU KNOW?

T: They're all the red ones

E: SO, ARE ALL THE BEARS IN YOUR HAND RED NOW?

T: Yes

E: DO YOU HAVE ALL THE RED BEARS THERE ARE HERE IN YOUR HAND?

M: No, he doesn't cause here's one by me Here, Tommy

E: NOW, DOES TOMMY HAVE ALL THE RED BEARS IN HIS HAND?

Ss: Yup yes guess he does

E: DO YOU HAVE SOME BEARS NOW KATY?

K: Uh huh

E: WHAT COLOR ARE YOUR BEARS?

K: The blue bears they like me

E: THAT'S GOOD--ARE ALL THE BEARS IN YOUR HAND BLUE ONES?

K: Yup

E: DID YOU MISS ANY OTHER BLUE ONES?

K: Nope all here they like me alot so they all came here

E: NOW, DO YOU THINK WE CAN SCRAMBLE THEM ALL UP TOGETHER AGAIN?

Ss: Well, OK Now I'll take a turn (etc.)

E: WHAT COULD WE CALL THIS BIG GROUP OF THINGS--WHEN IT'S ALL TOGETHER LIKE THIS?

Ss: I don't know Call it stuff call it camels again (laughter) no, they're bears

E: HERE ARE SOME OTHER ANIMALS--CAN YOU TELL WHAT THEY ARE?

Ss: rats no mice little mices look at their whiskers! I like them better than bears

E: COULD WE JUST MIX THEM IN WITH OUR BEARS NOW?

Ss: OK no all right

E: WHY DON'T WE? NOW, MIKE, CAN YOU MAKE A GROUP WITH SOME OF THESE THINGS?

T: No Well, how about the blue mice--only blue mice are over by me now

E: DO YOU WANT ANY OF THE OTHER BLUE ANIMALS IN YOUR GROUP TOMMY?

T: No, just the mice

K: I want the red mice, then! Here give 'em to me now

E: DO YOU GUYS THINK YOU COULD PUT THE RED AND THE BLUE MICE TOGETHER IN A GROUP?

Ss: No Why do that? they like to be like this (points)

E: (points to the bears) ALL THE BEARS ARE STILL TOGETHER. ARE THEY IN A GROUP DO YOU THINK?

Ss: No maybe a bear group (Tommy)

E: SINCE THAT'S A BEAR GROUP, COULD WE CALL THOSE TOGETHER (points again) A MICE GROUP, OR NOT?

Ss: No maybe why do that?

E: ARE THEY ALL MICE--WHETHER THEY'RE RED OR BLUE?

Ss: Yes sure lots'a mice

E: THEN COULD YOU PUT THEM ALL TOGETHER AND CALL IT A MICE GROUP?

Ss: Maybe yeah go ahead

E: LET'S TRY IT, OK? (they do it correctly) NOW WE'VE GOT HOW MANY GROUPS (points to bear group and then to mice group)?

Ss: one two [illegible] two groups now, right?

E: AND ONE GROUP IS WHAT?

T: Bears and one is mice

E: OK! LET'S SCRAMBLE THEM UP AND ADD THESE THINGS (gets out anchors) WHAT DO YOU WANT TO CALL THESE?

Ss: Tables hooks no tables they're little tables for the mice to eat on!

E: LET'S SEE WHAT KIND OF GROUPS YOU CAN MAKE OUT OF ALL THESE THINGS, OK?

(groupings were still very random--25 minutes was up)

SERIATION #1

E: WE'RE GOING TO BE MAKING SPECIAL KINDS OF GROUPS--GROUPS WHICH ARE IN ORDER. A GROUP IS A WAY OF PUTTING THINGS TOGETHER THAT ARE ALIKE IN SOME WAY. THIS MAKES IT EASIER TO THINK ABOUT THEM, OR REMEMBER THEM.

IN THIS ROOM WE COULD MAKE A GROUP OF PEOPLE, OR OF CHAIRS. GROUPS SHOULD PUT THINGS TOGETHER THAT ARE ALIKE IN SOME WAY. LET'S THINK ABOUT WHAT IS ALIKE OR THE SAME ABOUT ALL THE CHAIRS IN THIS ROOM.

Brandon: Same kind, same wood

E: THE CHAIRS ARE THE SAME KIND, BECAUSE SAME WOOD--RIGHT, BRANDON! IF WE MADE A GROUP OF TABLES IN HERE THEY MIGHT BE THE SAME. CAN YOU SEE HOW THEY WOULD BE THE SAME?

Jennifer: They have same wood, too--same color chairs--all are brown

E: THEY HAVE THE SAME KIND OF WOOD, AND MOST ARE THE SAME COLOR. THE TABLES ARE DIFFERENT IN SOME WAYS, TOO--FOR EXAMPLE, SOME OF THE TABLES ARE ROUND AND SOME ARE SQUARE (E points to tables).

Ss: There's a square one--it's bigger than this one

E: I'M GOING TO GET OUT SOME STICKS NOW, AND TELL YOU ABOUT A SPECIAL KIND OF ORDER WE MAKE WITH A GROUP. THERE'S A SPECIAL KIND OF GROUP WHERE YOU PUT THINGS INTO ORDER. THERE ARE MANY KINDS OF ORDERS OR WAYS TO PUT THINGS INTO AN ORDER. LOOK AT THESE STICKS--THEY'RE ALL STICKS, AREN'T THEY?

Ss: Yes yup, look like sticks of gum

E: THEY DO, DON'T THEY? WELL, THEY'RE ALL STICKS, BUT THEY ARE DIFFERENT LENGTHS (SOME ARE LONGER THAN OTHERS). ONE OF THE WAYS YOU CAN PUT THINGS INTO AN ORDER IS BY HOW LONG THEY ARE. THESE ARE ALL DIFFERENT LENGTHS, AREN'T THEY?

Ss: Yeah, right

E: AND THEY'RE ALL THE SAME BECAUSE THEY'RE STICKS. LET'S PUT THIS GROUP OF STICKS INTO AN ORDERED ROW. FIRST, WE HAVE TO FIND EITHER THE TALLEST OR THE SHORTEST STICK. HOW ABOUT YOU, NEAL, CAN YOU FIND EITHER THE TALLEST OR THE SHORTEST STICK? YOU MAY HAVE TO MEASURE BY HOLDING THEM NEXT TO EACH OTHER VERY CAREFULLY: BUT BE SURE YOU'RE RIGHT.

Neal: This one!

E: THAT'S WHICH--THE TALLEST OR THE SHORTEST?

N: tallest

E: TALLEST? RIGHT! OK, NOW LET'S PUT YOUR ROW RIGHT HERE IN FRONT OF YOU--CAN EVERYBODY SEE THIS ROW?

Ss: Yup, I can see it

E: NOW, LISTEN CAREFULLY. LOOK AT REST OF THE STICKS. YOU NEED TO FIND THE NEXT SHORTER STICK. IT WILL BE THE STICK WHICH IS THE MOST LIKE THAT FIRST STICK YOU PICKED, BUT JUST A BIT SHORTER. TRY IT. PUT IT RIGHT BESIDE THAT FIRST ONE IN YOUR ROW.

(N does this correctly)

E: THAT'S GOOD--YOU CAN MAKE SURE THE STICKS ARE IN YOUR ORDERED ROW VERY STRAIGHT (E shows this) TO BE SURE THAT YOUR ROW IS IN THE RIGHT ORDER.

YOU KNOW WHAT?

Ss: What?

E: THESE STICKS WILL LOOK JUST LIKE STAIR STEPS WHEN WE'RE DONE--IF IT'S RIGHT. NEXT, LOOK AT THE STICKS WHICH ARE LEFT. JUST ONE STICK LEFT. SEE IF THAT STICK IS THE LITTLEST ONE.

N: it is

E: NOW, CAN YOU PUT THAT LITTLEST STICK DOWN HERE SO THEY'RE ALL IN AN ORDERED ROW? (Jennifer places it correctly) THAT'S VERY GOOD! NOW, OUR ROW GOES FROM THE TALLEST OR BIGGEST STICK TO THE SHORTEST OR LITTLEST STICK, AND ALL THREE STICKS ARE IN ORDER. REMEMBER, THIS IS A VERY SPECIAL KIND OF GROUP BECAUSE IT HAS AN ORDER.

Neal: (points to two more sticks by me) what are these for?

E: WE'RE GOING TO DO MORE WITH THOSE STICKS IN JUST A FEW SECONDS, OK NEAL?

N: OK, good

E: LET'S SEE IF OUR ROW IS JUST RIGHT--WE STARTED WITH THE BIGGEST OR TALLEST STICK, THEN FOUND ONE WHICH WAS MOST LIKE THE FIRST ONE, BUT JUST A TINY BIT SHORTER (E points to each one) AND THIS ONE IS THE SMALLEST OR THE LITTLE TEENY ONE, RIGHT?

Ss: yeah, right, the baby one

E: THIS TIME, LET'S START OUR ORDERED ROW WITH THE BABY OR SMALLEST ONE. WHICH ONE WOULD COME NEXT, JENNIFER? WHICH ONE IS JUST A BIT BIGGER THAN THIS ONE?

(J puts last two sticks correctly in line)

E: VERY GOOD! NOW THIS ROW GOES FROM THE LITTLEST TO THE BIGGEST STICK--AND IT STILL LOOKS LIKE STAIR STEPS!

(E gets out two more sticks) NOW, LET'S SEE WHAT WOULD HAPPEN IF WE HAD A COUPLE MORE STICKS. THIS IS PRETTY TRICKY; THIS IS A HARD ONE! LET'S START WITH YOU, MICHAEL B, IN THE NEW SHOES!

M: OK

E: I'M GOING TO PUT THESE TWO NEW STICKS WITH ALL THE OTHERS AND MIX THEM UP INTO ONE BIG GROUP OF STICKS. MIKE, CAN YOU LOOK AT ALL THESE STICKS AND FIND THE VERY SHORTEST OR SMALLEST STICK?

(M does this correctly)

E: NOW, LOOK AT THE REST OF THE STICKS AND FIND THE NEXT BIGGER--THE STICK THAT'S JUST A BIT BIGGER THAN THE FIRST ONE YOU PICKED.

J: Can I help him?

E: IF IT'S OK WITH MICHAEL.

M: OK (they put correct one in line)

E: NOW, BE CAREFUL TO KEEP THE BOTTOMS OF YOUR STICKS IN A STRAIGHT LINE LIKE WE DID BEFORE. OK, NOW WHERE'S THE NEXT BIGGER STICK? THE ONE THAT'S MOST LIKE THIS ONE (points) BUT JUST A BIT BIGGER?

(they find it while E still talking)

NOW, WHERE'S THE NEXT BIGGER STICK?

(Neal picks out wrong one; Brandon shakes head "no")

E: WE HAVE TO BE CAREFUL TO PICK THE STICK THAT'S JUST A BIT BIGGER. IS IT THE ONE NEAL IS HOLDING? BRANDON DOESN'T THINK SO. WHY NOT, BRANDON?

B: (picks up correct stick) this one's next bigger--I can see it!

E: DOES THAT ONE LOOK MORE LIKE THE LAST ONE IN YOUR LINE, NEAL? (nods yes) THEN WHERE DOES IT GO IN YOUR ORDERED LINE OR ROW? (N places it correctly)

NOW, LOOK AT OUR ROW. EACH ONE IN LINE OR ROW GETS A LITTLE BIT TALLER--JUST LIKE GOING UP STAIR STEPS AGAIN. HOW DOES IT LOOK TO YOU GUYS?

B: It looks fine J: good N: like stairs now

E: NOW, I'VE GOT A PROBLEM FOR YOU--WE NEED TO SWITCH OUR ORDERED ROW AROUND SO THAT INSTEAD OF STARTING WITH THE LITTLEST OR SHORTEST ONE, WE START WITH THE BIGGEST ONE. LET'S GIVE IT A TRY.

THERE'S THE BIGGEST ONE (E points). WHAT STICK WOULD COME NEXT? WHERE'S THE ONE THAT'S JUST A LITTLE BIT SHORTER? WHERE'S THE NEXT SMALLER ONE?

(N picks correct one and M nods - OK)

GOOD! JENNIFER--WHY DON'T YOU SHOW US THE NEXT SMALLER ONE--THE ONE WHICH SHOULD BE NEXT IN LINE. (J does so)

E: VERY GOOD! (this continues, with Ss taking turns placing the "next smaller" stick in line until Neal places last one)

NOW, NEAL, IS THAT THE VERY SMALLEST STICK? IT SHOULD BE IF IT'S THE LAST ONE WE PLACE IN OUR ROW.

N: it's the smallest B: great!

E: GOOD (puts sticks away) HOW WOULD YOU LIKE TO PLAY WITH SOME DUCKS NOW?

Ss: yeah, OK, etc.

E: HERE'S THE VERY BIGGEST DUCK--SHOULD WE MAKE IT THE FATHER OR THE MOTHER DUCK?

Ss: father duck

E: OK; NOW THIS FATHER DUCK HAS A PROBLEM, THE MOTHER DUCK WENT AWAY FOR AWHILE AND SAID TO THE FATHER '

MAYBE THE BEST WAY TO KEEP TRACK OF ALL THREE OF YOUR BABIES IS TO PUT THEM INTO SOME KIND OF AN ORDER.

B: Can I have a turn now?

E: SURE; (B has already started to seriate them) YOU'RE STARTING WITH THE VERY SMALLEST DUCK, AND YOU'RE GOING TO MAKE YOUR ROW GO IN THAT DIRECTION (points) OK, WHERE'S THE BIGGEST ONE?

B: here (points to it)

E: LET'S LOOK AT YOUR CHILDREN FATHER DUCK. HOW DOES THIS ROW GO?

J: little, bigger, biggest baby ducks!

B: or big, bigger, biggest

E: NOW, IF YOU WANTED TO PUT THE FATHER DUCK IN LINE TOO, WHERE WOULD HE GO, JENNIFER?

J: at this end, 'cause he's the biggest

E: RIGHT!

J: I love the father duck!

E: I LIKE HIM, TOO. NOW, I'VE GOT SOME MORE THINGS FOR YOU TO PUT IN ORDER. (E puts away ducks and brings out butterflies in different shades of pink and after that different shades of blue). THESE ARE THE SAME BECAUSE THEY ARE ALL BUTTERFLIES, AND THEY ALL HAVE COLORS. BUT THEY ARE DIFFERENT IN A VERY SPECIAL WAY.

S: There's a light one--almost like white!

E: GOOD! SOME OF THE BUTTERFLIES ARE LIGHTER OR DARKER THAN OTHERS. WE CAN PUT THESE INTO AN ORDERED ROW JUST LIKE WE DID WITH THE DUCKS AND THE STICKS.

FIRST, WE HAVE TO FIND THE BUTTERFLY WHICH IS EITHER THE LIGHTEST OR THE DARKEST. WHICH SHOULD WE START WITH?

Ss: (J) the light one (others: OK) J picks it up

E: OK, NOW WE NEED TO FIND ONE FOR OUR ORDERED ROW THAT'S JUST A LITTLE DARKER THAN THIS FIRST ONE. THIS IS TRICKY--CAN YOU FIND THE ONE WHICH SHOULD BE NEXT TO HIM IN LINE?

(B finds it and puts it in line)

E: VERY GOOD! NOW, LOOK AT THE BUTTERFLIES WHICH ARE LEFT AND SEE IF YOU CAN TELL WHICH SHOULD COME NEXT IN OUR ROW. WHERE'S THE NEXT DARKER ONE?

M: is it this one? (wrong one) J: I don't think so

E: LOOK VERY CAREFULLY AT THESE LAST TWO BUTTERFLIES--THEY ARE ALMOST THE SAME COLOR, BUT THIS ONE (points) IS JUST A BIT LIGHTER. THAT MEANS IT'S MOST LIKE THE LAST ONE IN LINE AND SHOULD COME NEXT. CAN YOU (to M) SEE THAT IT'S A BIT LIGHTER AND SHOULD COME NEXT?

M: Yeah guess so (puts in correct place)

E: GOOD! NOW PUT THE LAST, DARKEST BUTTERFLY IN LINE TOO. THAT'S RIGHT! NOW LOOK AT OUR ORDERED ROW. IT SHOULD GO FROM THE LIGHTEST TO THE DARKEST. IS IT JUST RIGHT?

Ss: yes right (etc.)

E: (puts butterflies away) SO FAR WE'VE PUT THINGS INTO ORDERED ROW BY HOW BIG OR TALL THEY WERE AND HOW LIGHT OR DARK THEY WERE--DID YOU KNOW WE CAN EVEN PUT THINGS INTO ORDER BY HOW HEAVY THEY ARE?

Ss: no how sure you can

E: HERE ARE THREE JARS WITH WEIGHTS IN THEM. THE WEIGHTS ARE ALL DIFFERENT. WE CAN PUT THESE WEIGHTS INTO AN ORDERED ROW.

FIRST, YOU HAVE TO PICK THEM ALL UP AND COMPARE OR SEE HOW HEAVY THEY ARE.

(Ss do this) NEXT, YOU SHOULD FIND EITHER THE LIGHTEST OR THE HEAVIEST--LET'S START WITH THE LIGHTEST, OR THE EASIEST TO HOLD.

(M finds it) OK, MIKE, YOU'RE SURE THAT'S THE LIGHTEST WEIGHT?

M: Yup.

E: NEXT YOU NEED TO FEEL THE WEIGHTS WHICH ARE LEFT AND FIND THE ONE THAT FEELS MOST LIKE THE FIRST ONE, BUT JUST A BIT HEAVIER.

J: It's this one (E checks to be sure)

E: RIGHT! THEN THIS ONE SHOULD BE THE HEAVIEST ONE AND IT GOES ON THE END OF OUR ORDERED ROW OF WEIGHTS.

SO WE CAN PUT THINGS INTO ORDER BY HOW MUCH THEY WEIGH, HOW TALL OR LONG THEY ARE, AND HOW LIGHT OR DARK THEY ARE.

(E puts weights away and gets out three bears materials)

LOOK AT THESE THREE BEARS. THEY ARE ALL BEARS, BUT THEY ARE DIFFERENT SIZES. MAYBE YOU CAN HELP ME TELL THE STORY. JENNIFER, CAN YOU PUT THESE BEARS INTO AN ORDERED ROW LIKE WE'VE BEEN DOING? FIRST, REMEMBER YOU MUST LOOK CAREFULLY AT ALL THREE BEARS. WHICH SHALL WE START WITH--THE BIGGEST OR SMALLEST BEAR?

J: the daddy bear--the biggest one!

E: FINE. NOW IF WE STARTED WITH THE BIGGEST BEAR, YOU HAVE TO FIND ONE THAT'S JUST A LITTLE BIT SMALLER THAN DADDY BEAR TO COME NEXT IN YOUR ROW.

(J puts mother bear next in row)

E: NOW, LOOK WHO'S LEFT--THE VERY SMALLEST BEAR

J: Here's the baby bear!

E: IT'S VERY COLD, AND WHEN IT'S COLD EVEN BEARS NEED TO WEAR CLOTHES. HERE ARE SOME CLOTHES FOR THE THREE BEARS. IT'S VERY IMPORTANT TO GIVE THE RIGHT-SIZED CLOTHES TO THE RIGHT-SIZED BEAR, SO THEY WILL FIT JUST RIGHT. MICHAEL, CAN YOU GIVE THE BEARS THEIR RIGHT-SIZED CLOTHES? YOU WILL PROBABLY HAVE TO PUT THEM IN AN ORDERED ROW TO BE SURE YOU ARE RIGHT. CAN YOU GIVE THE FATHER BEAR THE BIGGEST CLOTHES SINCE HE'S THE BIGGEST BEAR?

(M does so without difficulty)

E: SO, THOSE WERE THE BIGGEST CLOTHES? M: Yeah, big bear clothes they fit

E: THAT'S RIGHT--THE BIGGEST CLOTHES FOR THE BIGGEST BEAR, SO THEY GO TOGETHER

Mike finished giving the right-sized clothes to the 3 bears

E: NOW LOOK--THE CLOTHES ARE IN AN ORDERED ROW, TOO. HOW ABOUT THAT?

Ss: Yeah

E: THERE'S THE BIGGEST (pointing) CLOTHES FOR THE BIGGEST BEAR, AND THAT ONE'S A LITTLE BIT SMALLER FOR THE MIDDLE SIZED BEAR, AND HERE'S THE LITTLEST CLOTHES FOR THE LITTLEST BEAR.

B: I like that one!

E: NOW THE BEARS ARE GETTING HUNGRY, AND THEY NEED TO SIT AT THEIR TABLE FOR BREAKFAST. HERE ARE SOME CHAIRS FOR THEM TO SIT ON. NEAL, CAN YOU GIVE EACH BEAR THE RIGHT CHAIR? THEN THE CHAIRS WILL MAKE ANOTHER ORDERED ROW--LIKE THE ROW OF BEARS AND THEIR CLOTHES.

N: Sure; (finishes with baby bear) little chair for baby bear; OK

E: GOOD! NOW, JENNIFER, HERE ARE SOME SPOONS FOR THE BEAR FAMILY TO EAT THEIR CEREAL WITH. CAN YOU GIVE EACH BEAR THE RIGHT-SIZED SPOON? YOU WILL HAVE TO PUT THE SPOONS INTO AN ORDERED ROW TO BE SURE YOU ARE RIGHT.

J: Here's one for you, Daddy bear, and one for you mamma and the baby one for you baby bear. OK

E: VERY GOOD. NOW LOOK AT ALL OUR ORDERED ROWS! EACH ROW STARTS

WITH THE BIGGEST THING AND EACH THING IN THE ROW GETS SMALLER, RIGHT.

J: Right   B: Yeah

E: NOW, MIKE, CAN YOU PUT THESE BOWLS OF CEREAL INTO ANOTHER ORDER LIKE THESE OTHERS, SO WE CAN BE SURE TO GIVE THE RIGHT-SIZED BOWL TO THE RIGHT-SIZED BEAR.

M: OK--this one's for you daddy bear, here's yours mamma bear, and this tiny one must be for the baby bear, right?

E: GOOD! (gets out three beds).

B: Look at those beds

E: THAT'S RIGHT BRANDON; THE BEDS COME LAST--THE BEARS HAVE EATEN NOW AND WANT TO TAKE A NAP. CAN YOU PUT THE BEDS INTO A SPECIAL ORDER, SO EACH BEAR SLEEPS IN THE RIGHT-SIZED BED? THEY'D LIKE THAT I THINK.

(B does so quickly)

E: NOW LOOK AT ALL THESE THINGS--BEARS AND CLOTHES AND CHAIRS AND SPOONS AND BOWLS AND BEDS--EVERYTHING IS IN AN ORDER STARTING WITH--WHICH, THE BIGGEST OR THE SMALLEST?

Ss: the biggest!!

E: RIGHT (Points to middle-sized things) AND THE NEXT THINGS IN OUR LINES ARE WHAT--BIGGEST OR MIDDLE-SIZED?

Ss: Middle-sized middle-ones

E: OK, NOW LET'S SWITCH ALL OF OUR ORDERED ROW SO WE START WITH BABY BEAR THIS TIME (each S does a row, switching the order--little help from E necessary).

E: SO FAR TODAY, WE'VE PUT LOTS OF DIFFERENT KINDS OF THINGS INTO ORDERED ROWS OR LINES, HAVEN'T WE?

Ss: Yes

E: LET'S SEE--WE'VE PUT THINGS INTO ORDER BY LENGTH OR HOW LONG THEY ARE, WE'VE PUT THINGS INTO ORDER BY SIZE, OR HOW BIG THEY ARE, WE'VE PUT THINGS INTO ORDER BY HOW LIGHT OR DARK THEY ARE, AND NOW I'LL SHOW YOU SOME OTHER WAYS WE CAN PUT THINGS INTO ORDERED ROWS, OK? NEXT TIME WE GET TOGETHER WE'LL PRACTICE ALL THESE WAYS OF PUTTING THINGS INTO ORDER.

(E gets out cards with different number dots on them) LOOK AT THESE CARDS.

(Ss start counting dots on them spontaneously)

E: YES, YOU SEE THEY EACH HAVE A DIFFERENT NUMBER OF DOTS ON THEM. WE CAN MAKE AN ORDERED ROW OUT OF THESE CARDS, THINKING ABOUT HOW MANY DOTS EACH ONE HAS. LET'S START WITH THE CARD WITH JUST ONE DOT. WHERE IS IT?

J: Right here

E: OK, NOW NEXT WE'D NEED THE CARD WITH JUST ONE MORE DOT ON IT.

B: Here's it--two dots, there's three, and here's four (finishes row)

E: THAT'S GREAT BRANDON. (puts cards away and gets out three weights concealed in jars. NOW SOMETIMES WE CAN MAKE AN ORDER WITHOUT SEEING THE THINGS WE'RE PUTTING INTO ORDER. HERE ARE SOME JARS WITH WEIGHTS OR HEAVY THINGS IN THEM. YOU WILL NEED TO PICK UP EACH ONE AND COMPARE THEM TO FIND OUT WHICH ONE TO START WITH IN YOUR ROW. NEAL, CAN YOU FIND THE VERY HEAVIEST WEIGHT? REMEMBER YOU HAVE TO PICK EACH ONE UP AND COMPARE BEFORE YOU WILL BE SURE.

N: (plays that each are very heavy) oh, this one is sooo heavy

E: (checks it) OK! THAT ONE IS THE HEAVIEST ONE. NOW FEEL THE TWO WHICH ARE LEFT AND TELL ME WHICH ONE IS MOST LIKE THIS FIRST ONE--BUT JUST A BIT LIGHTER (OR NOT AS HEAVY).

N: This one, I think, this is tricky!!

E: IT SURE IS--BUT THAT'S THE RIGHT ONE; SO THIS ONE MUST BE THE LIGHTEST ONE OR ONE THAT'S EASIEST TO PICK UP, SO YOU CAN PUT IT AT THE END OF YOUR ROW.

(N does this)

(E puts weights away and gets out jars filled with different amounts of potting soil)

E: HERE IS ANOTHER WAY YOU CAN PUT THINGS INTO ORDER--BY HOW MUCH THEY HAVE (OF SOMETHING). LOOK AT ALL THE JARS, BRANDON--WHICH ONE HAS THE TINIEST AMOUNT OF DIRT? JUST A LITTLE BIT OF DIRT.

B: This one does--I think

E: OK, NOW JENNIFER, CAN YOU FIND THE JAR THAT LOOKS MOST LIKE THIS ONE? ONE WITH JUST A WEE BIT MORE DIRT IN IT?

J: This one, and then comes this one, and that...is this right? Does it look right to you? (finishes row!!)

E: THAT'S GOOD. NOW, BEFORE YOU GO BACK TO THE ROOM YOU CAN EACH TAKE ONE OF THESE SET OF MATERIALS WE'VE BEEN PLAYING WITH AND PUT THEM INTO ORDER, OK? I'LL CHECK TO BE SURE YOU'RE DOING IT RIGHT.

SERIATION #2

E: (shows sticks): WHAT DO YOU WANT TO CALL THESE?

Ss: I don't care (Lance) big, bigger, biggest (Andy) biggest, bigger, biggest

E: HMMMM; BIG, BIGGER, BIGGEST--WHAT?

Andy: sticks?

E: OK, STICKS; WHAT'S DIFFERENT ABOUT THESE STICKS? WHY ARE THEY DIFFERENT?

Ss: Well, 'cause there's little ones and bigger ones (Jordan); cause, well one's bigger and one's smaller, and one's even smaller (Andy); or one's medium and one's smaller yeah. (Andy spontaneously seriates the sticks)

E: ANDY, DID YOU JUST DO SOMETHING WITH THOSE STICKS?

J: What did he do?

A: Smaller and smaller an' smaller (then made them into graphic display)

E: OK, JORDAN, DO YOU WANT TO TRY TO DO SOMETHING WITH THOSE STICKS?

J: Yup! (puts in random fashion)

E: JORDAN IS MAKING A DESIGN (said for benefit of tape) ANDY, DO YOU REMEMBER WHAT YOU DID WITH THEM? COULD YOU DO IT AGAIN?

B: I don't know (makes random array, similar to Jordan's)

E: BRENT, DO YOU WANT A TURN NOW?

B: Yup, want to see what I made (random array) they go like this--here's a four--see it?

E: UM HUM--CAN ANYBODY PUT THEM INTO SOME KIND OF ORDER--I THINK ANDY DID ONCE?

A: I did once

J: Let me try

A: You already got your turn Jordan!

J: I thought I get another one!

E: YOU'LL GET LOTS OF TURNS, OK?

Ss: OK, good

E: (points to biggest or longest stick) IS THIS ONE THE BIGGEST OR THE SMALLEST STICK?

Ss: Biggest one

E: (points to smallest) AND WHAT ABOUT THIS ONE?

Ss: Smallest

(E starts to point to stick left, and B says "medium sized one"

E: OK, AND WHERE WOULD THAT ONE HAVE TO GO, IF THESE WERE IN ORDER?

B: That one would have to go right there (puts it in line correctly)

E: HOW CAN YOU BE SURE YOU'RE RIGHT, BRENT? ARE YOU SURE THAT'S RIGHT OR IN THE RIGHT PLACE?

B: Cause this one's bigger (points) and this one's medium and this one's small. I can go from this one to this one up to that (goes up with fingers like stairs)

E: OK, YOU STARTED WITH WHICH ONE THIS TIME?

B: The biggest

E: YOU STARTED WITH THE BIGGEST THIS TIME, SO WHY DON'T YOU START WITH THE SMALLEST THIS TIME--CAN YOU DO THAT?

J: I want to when he's done

E: FINE

(B starts with smallest) B: there, that one there (has some trouble with two bigger ones, changes row

E: (points to next-bigger one, now correctly placed): is this one the next bigger or not?

B: It's OK , and here's a biggest one, right?

E: NOW IT'S JORDAN'S TURN

(Jordan puts biggest one in middle

B: a .. that's not right

E: JORDAN HAS THE BIGGEST IN THE MIDDLE DOESN'T HE? HOW ARE YOU GOING TO DO IT BRENT?

(Brent does it correctly again)

E: NOW LANCE, CAN YOU PUT THEM INTO SOME KIND OF ORDER?

(he makes them into letter "L") L: there's an L in my name--see it?

E: OH, YEAH; DO YOU THINK YOU CAN PUT THEM INTO AN ORDER STARTING WITH EITHER THE TINIEST ONE OR THE BIGGEST ONE LANCE?

L: (plays with sticks, has trouble getting started, others start to help him)

E: WELL, HAVE YOU DECIDED WHICH ONE TO START WITH? THE BIGGEST OR THE SMALLEST?

L: Now it's a capital I

J: Looks like an airplane I think

E: GEE, YOU'VE MADE ALOT OF SHAPES, NOW DO YOU THINK YOU CAN PUT THEM INTO AN ORDER--MAYBE SIDE-BY-SIDE SOMEHOW?

L: Maybe it's easier to put them up higher--look at this one (continues graphic)

E: (puts sticks away and gets out ducks)

Ss: Oh, oh! look at those funny ducks (etc.)

E: YOU LIKE THESE? WHAT ARE THEY CALLED?

Ss: Ducks!

E: HOW ARE THESE DUCKS DIFFERENT? WHAT'S DIFFERENT ABOUT THEM?

E: (Ss begin quacking) AND YOU'RE QUACKING JUST LIKE DUCKS? (points to biggest duck in random array) WHICH DUCK IS THIS ONE? WHAT SHALL WE CALL HIM?

Ss: They quack different--quack, quack (etc.)

E: LOOK VERY CLOSELY, OK? WHAT ELSE IS DIFFERENT ABOUT THESE DUCKS?

J: I'm the daddy duck! (others still quack some) J: big, bigger. . .

E: WHAT DID YOU SAY JORDAN?

J: Big, bigger ducks--there's the daddy duck

E: MAYBE YOU CAN BRING ALL THE DUCKS OVER TO YOU--WHERE'S THE FATHER DUCK (gets it from Brent)

NOW, CAN YOU HELP LINE THEM UP INTO SOME KIND OF A ROW?

Brent: I will (others echo: I will, I will)

E: OK, BRENT, LET'S SEE HOW YOUR ROW WILL LOOK, THEN EVERYONE ELSE CAN HAVE A TURN--ALLRIGHT?

B: Then this is the mother duck

E: IS SHE A LITTLE BIT BIGGER OR A LITTLE BIT SMALLER THAN THE FATHER DUCK?

B: Bigger, well, (A says smaller Brent!) B: smaller

J: The little ones in the way (takes a couple smaller ones)

E: CAN YOU BRING THOSE ~~BACK TO THEIR FAMILY~~? SO B CAN FINISH HIS ROW?

J: Well, OK Quack, him gonna come now quack quack

B: I think I'm thru now

E: OK, YOU SAID THAT WAS THE FATHER? B: Yeah

E: AND HOW ARE THEY GONNA LINE UP?

B: This is big (points to mother) so the mother goes there

E: HMM, THE MOTHER GOES NEXT, THEN WHAT?

B: One of the babies, and this baby (these two are not in a line, but in a "bunch")

E: IS THERE A WAY YOU COULD MAKE THEM IN A LINE?

B: OK, the father, the mother, and a baby go next, and another baby go next

E: WHICH BABY IS SMALLER--WHERE'S THE SMALLEST BABY?

B: Here, this one (begins quacking in high-pitched baby duck sounds)

E: SO THE SMALL ONE IS AT THIS END?

B: Yup E: LOOK WHAT HE'S DONE! ARE THEY IN A ROW NOW?

Ss: Yes guess they are dunno

E: HAVE YOU EVER SEEN DUCKS WALKING DOWN TO THE LAKE?

Ss: Yeah

E: DID THEY GO IN A ROW LIKE THIS?

Ss: Yup--down to the lake. Him going down to lake (J)

E: WHICH ONE'S DOWN HERE? IS THAT THE BIGGEST ONE OR THE LITTLEST ONE LANCE?

L: Littlest one

E: WHICH ONE IS LEADING THE WAY--I GUESS YOU CALLED HIM FATHER DUCK--IS HE THE BIGGEST OR LITTLEST?

Ss: big biggest

E: (points to each successive duck in row) and is this a bit smaller/bigger?

Ss: bigger, no smaller, that one's a little bit smaller

E: OK, I'LL TAKE THE DUCKS NOW

J: Here's the big one (hands to E)

E: HERE ARE SOME BUTTERFLIES (different shades of pink and then set of blue ones)

Ss: Butterflies oh boy hmmm J: I want to fly B: you're not gonna fly them

E: NOW, ARE THOSE BUTTERFLIES THE SAME COLOR OR ARE THEY DIFFERENT?

Ss: (B) different colors

E: DO YOU THINK WE COULD PUT THEM INTO SOME KIND OF AN ORDER TOO?

Ss: Yes I really like 'em (B)

E: WANT TO TRY IT, BRENT? (starts to put them in random order--playing with them)

B: And this one goes like this--on your back and then this one (etc) points to two butterflies

E: WHAT'S THIS ONE? IS IT LIGHTER OR DARKER?

Ss: Lighter J: lighter I guess A: it's lighter I can see that

E: AND HOW ABOUT THIS ONE? IS IT LIGHTER OR DARKER?

Ss: Darker

E: CAN YOU THINK OF A WAY TO PUT THEM IN ORDER NOW?

B: Let's try again--now this one goes here and then this goes next let's see (gets half right)

E: ARE SOME OF YOUR COLORS DARKER THAN OTHERS? B: yes--these are dark down here. (pts to one end of row)

Ss: fly'm fly fly away (begin to fly butterflies)

E: OK, FLY THE BUTTERFLIES BACK

(E puts away butterflies and gets out 3 weights, concealed in painted jars)

Ss: What are those?

E: THEY'RE WEIGHTS; CAN YOU FEEL THEM?

E: WANT TO FEEL THESE WEIGHTS?

Ss: Oh heavy one lift this one (etc) give me all the light ones and see if I fall down

E: DO YOU THINK WE CAN PUT THESE WEIGHTS IN SOME KIND OF AN ORDER?

Ss: I want to do it first no me

E: OK, BRENT'S GOING TO TAKE A TURN, THEN YOU ANDY, AND SO ON, OK?

Ss: All right

B: (starts to feel them and line them up) this is big one, this is biggest this is a small one

E: WHERE'S THE HEAVIEST ONE? CAN YOU POINT TO THE HEAVIEST WEIGHT?

B: This is the most heavy one

E: WHERE'S THE LIGHTEST ONE?

B: This is the most light

E: ANDY'S TURN NEXT--I THINK I'LL SCRAMBLE THEM ALL UP, OK?

A: OK; let's see now

E: ANDY, ARE YOU GOING TO START WITH THE LIGHTEST OR THE HEAVIEST?

A: This is hard--here feel this one (background discussion about who's going next, etc.)

E: IS THAT ONE THE HEAVIEST ONE?

A: Let Lance try it

E: I'M STARTING WITH THIS ONE SEE? E: IS IT THE LIGHTEST OR--

L: It looks like a "c" my row is a letter

B: That's not right

J: My turn now, OK?

E: LET'S SEE WHAT KIND OF ROW JORDAN CAN MAKE WITH THESE WEIGHTS, OK?

(sings and makes sounds while he works) piled them up with heaviest one on the bottom (others copied this way of ordering--most were not correct)

(E puts weights away and brings out three bears' materials)

E: WE'RE GOING TO DO SOMETHING WITH THESE NOW

Ss: Three bears? E: UM HUM

E: YOU'LL EACH GET A TURN AT HELPING ME TELL THE STORY. ANDY, LET'S START WITH YOU. CAN YOU PUT THE THREE BEARS INTO SOME KIND OF ORDER?

A: Like this (correct) started with smallest bear

E: NOW LANCE, CAN YOU PUT THESE CLOTHES ON THE BEARS IN A SPECIAL WAY?

(L starts) WHO ARE YOU GIVING THOSE LITTLE CLOTHES TO?

L: The baby bear, and here are the mother's clothes

E: AND WHO ARE YOU GIVING THE BIGGEST CLOTHES TO? L: The Papa bear and the littlest bear is on the very end

E: JORDAN (points to beds) WHAT ARE THOSE THINGS? WHAT DO YOU THINK THEY ARE?

J: Beds, can I do them?

E: SURE; CAN YOU GIVE EACH BEAR A BED?

(J puts the bears in beds, but takes them ~~out~~ of a line and puts the mother bear in the biggest bed--perhaps because mother-bear is wearing blue and the big bed has a blue cover)

B: That's not right is it?

E: WELL, IT LOOKS LIKE HE PUT THE BEAR WITH BLUE CLOTHES IN THE BLUE BED. DO YOU SEE ANOTHER WAY TO DO IT BRENT?

(puts them in correct beds, still not in order, too

E: SO YOU WANT TO PUT THIS BIGGEST BEAR IN THE BIGGEST BED?

B: Yeah, the little bear in the tiny bed and this is mama bear's bed right here (points to each one)

E: NOW ARE THEY ALL ASLEEP? Ss: Right shhh!

E: WHAT BED IS THE BABY BEAR IN? Ss: The little one

E: WHAT ABOUT MAMA BEAR--WHAT BED IS SHE IN?

Ss: The little the littler no the uh medium, the medium (really struggled to get right word here!)

E: WHAT ABOUT THE BIG DADDY BEAR--WHAT BED IS HE IN?

Ss: Biggest bed, biggest bed (all echo this response)

E: LOOK AT THESE (brings out chairs)

Ss: Chairs

E: HERE'S SOME CHAIRS, MAYBE FOR IN THE KITCHEN. BRENT, CAN YOU DO THESE? CAN YOU GIVE EACH BEAR A CHAIR?

B: And this one sits here, and this one right there this one's for the mama

E: OK, CAN YOU PUT THE CHAIRS BESIDE THEIR BEDS, SO WE CAN BE SURE THAT THE RIGHT BEAR WILL SIT IN THE RIGHT CHAIR?

B: Now you stay in your beds; lie down, yup that's the right bed for you (etc.)

E: ARE THESE ALL IN THE RIGHT ORDER NOW--DO YOU THINK?

(B moves them)

B: Little and bigger and biggest one--that's it

E: (gets out bowls) MAYBE THE BEARS ARE READY TO GET UP NOW AND

ARE GETTING HUNGRY. DO YOU THINK THEY ARE?

Ss: Yup (have them get out of beds) What are those--bowls? what for?

E: THESE ARE BOWLS FOR THE BEARS. CAN YOU GIVE A BOWL TO EACH BEAR ANDY?

(A does so without seriating first)

E: GOOD, NOW THEY NEED SOMETHING TO EAT WITH--LOOK AT THESE (SPOONS) JORDAN, WHO WOULD YOU GIVE THESE DIFFERENT SPOONS TO?

J: Let's see I'm not sure

E: WHO WOULD YOU GIVE THIS BIGGEST SPOON TO?

J: You! E: OF THE BEARS, I MEAN. WHICH BEAR?

J: Is this supposed to go here? (gives to biggest bear)

E: THAT LOOKS PRETTY GOOD TO ME. AND WHAT BEAR GETS THE MIDDLE-SIZED SPOON, DO YOU THINK?

J: That one? Yeah - to mama bear, right?

E: YOUR'RE DOING FINE--THAT LEAVES WHAT ONE?

J: Tiny one for baby bear, baby bear (starts singing like a baby bear!).

E: LET'S LOOK AT ALL THESE THINGS, OK? ARE THEY ALL IN SOME KIND OF ORDER, OR NOT.

Ss: Yes order little, bigger, biggest I dunno (etc.)

E: WE'VE PLAYED WITH MANY THINGS TODAY, HAVEN'T WE? DO YOU REMEMBER ANY OF THEM?

Ss: Butterflies

E: WHAT WAS DIFFERENT ABOUT THE BUTTERFLIES?

Ss: Dunno maybe color yeah, color, I think so

E: WHAT ELSE?

J: Ducks (quack, quack)

E: IS THAT ALL?

Ss: The three bears--that's all

E: HERE ARE SOME MORE THINGS, THEN I'LL LET YOU PLAY WITH WHATEVER YOU WANT TO FOR A LITTLE WHILE, OK?

Ss: What's those?

E: SOME JARS WITH POTTING SOIL OR DIRT IN THEM. CAN YOU SEE ANYTHING DIFFERENT ABOUT THEM?

Ss: No

E: DO THEY ALL HAVE THE SAME AMOUNT OF DIRT IN THEM?

Ss: No, that one has some more all different or about all different

E: DO YOU THINK THERE WOULD BE A WAY TO PUT THESE INTO AN ORDER?

Ss: How? pile them up or something?

E: COULD YOU START WITH THE ONE WITH EITHER THE MOST DIRT IN IT OR THE LEAST DIRT IN IT--WHAT DO YOU THINK?

B: Oh, let's see--here's the most, I think (picks next to most)

E: OK, ARE YOU SURE IT HAS THE MOST DIRT?

B: This one has more--yeah, then this, and then that one, I can't tell about these ones

(finished all but last two--turned around)

E: PRETTY GOOD, BRENT! CAN EVERYBODY SEE HOW HE PUT THEM INTO AN ORDER? STARTED WITH WHICH--THE MOST DIRT OR THE LEAST?

A: Most dirt

E: AND EACH ONE HAS WHAT--A LITTLE MORE OR A LITTLE LESS?

Ss: Dunno A: a little less B: right, Andy, that's how it goes

E: YOU'VE DONE ALOT TODAY. NOW YOU CAN PLAY WITH SOMETHING WE'VE USED, OK?

Ss: Good are we done now? (etc.)

# LESSON RATING SHEET

Note: Please rate the lesson scripts by circling the appropriate number. The numbers are explained in each section of this rating sheet. For comparison questions it is important to rate both lessons' plans before answering.

I. Teacher Direction of the lesson: for each lesson listed below the numbers signify the following:

1 = no teacher direction
2 = very little teacher direction
3 = some teacher direction
4 = almost entirely teacher directed
5 = entirely teacher directed

| Lesson: | | | | | |
|---|---|---|---|---|---|
| Seriation #1: | 1 | 2 | 3 | 4 | 5 |
| Seriation #2: | 1 | 2 | 3 | 4 | 5 |
| Classification #1: | 1 | 2 | 3 | 4 | 5 |
| Classification #2: | 1 | 2 | 3 | 4 | 5 |

II. Teacher statements: for each lesson listed below the numbers signify the following:

1 = no factual, expository statements
2 = very few factual statements
3 = some factual statements
4 = most statements factual
5 = all statements factual

| Lesson: | | | | | |
|---|---|---|---|---|---|
| Seriation #1: | 1 | 2 | 3 | 4 | 5 |
| Seriation #2: | 1 | 2 | 3 | 4 | 5 |
| Classification #1: | 1 | 2 | 3 | 4 | 5 |
| Classification #2: | 1 | 2 | 3 | 4 | 5 |

III. Overall comparisons: for each set of lessons listed below, the numbers signify the following:

1 = no difference (between the two)
2 = very few differences
3 = some differences
4 = very different (very many differences)
5 = entirely different

Lessons:

| | | | | | |
|---|---|---|---|---|---|
| Seriation #1 vs. Seriation #2: | 1 | 2 | 3 | 4 | 5 |
| Classification #1 vs. Classification #2: | 1 | 2 | 3 | 4 | 5 |
| Seriation #1 vs. Classification #1: | 1 | 2 | 3 | 4 | 5 |
| Seriation #2 vs. Classification #2: | 1 | 2 | 3 | 4 | 5 |

Please comment on specifically what you felt were differences and/or similarities in the lesson plans:



(continue on reverse side) THANKS SO MUCH!

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