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ABSTRACT

Inconsistencies in the use of terminology to describe instructional treatments, confounding of discovery and expository methods with other aspects of instruction, and inconsistencies in defining independent and dependent variables within and between studies have all contributed to the lack of definitive conclusions about the effectiveness of different instructional methods. The purpose of this study was to compare the effectiveness of three instructional methods, i.e., expository, discovery, and a modified form of discovery, Component Display Theory, which incorporated the rule given in the expository lesson using a theoretical paradigm for analyzing the components of instruction. The subjects were 50 third-graders from Syracuse, New York, and a concept taken from beginning set theory in conceptual mathematics was selected as the task. While none of the instructional treatments proved to be significantly better on the overall test incorporating both application and transfer subscales, a few differences did emerge through analysis of the subscale results. The findings indicated that explicitly providing a generality, whether at the beginning or at the end of a lesson, will facilitate performance on applying that generality. A 15-item reference list is provided. (RP)

## INSTRUCTIONAL DESIGN, DEVELOPMENT, AND EVALUATION

# WORKING PAPERS

A COMPARISON OF THREE
INSTRUCTIONAL PRESENTATION FORMATS

by

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# INTRODUCTION

The purpose of this study was to compare the effectiveness of three instructional methods -- expository, discovery, and a modified form of discovery which incorporated the rule given in the expository lesson. In order to overcome some of the problems of confounding variables and inconsistent terminology and definitions of these methods found in previous investigations, this study uses a theoretical paradigm for analyzing the components of instruction -- Component Display Theory (Merrill, in press).

Discovery and expository methods of instruction have been studied in a variety of educational contexts for over twenty years, yet the debate still continues over which type of method is the most effective. Inconsistencies in the use of terminology to describe instructional treatments, confounding of discovery and expository methods with other aspects of instruction, and inconsistencies in defining independent and dependent variables within and between studies have all contributed to the lack of definitive conclusions about the effectiveness of expository and discovery methods of instruction.

## Inconsistent terminology.

In a review of the literature on expository and discovery learning conducted in 1980, B. Keller (Note 1) found that such studies used a variety of different terms to describe instruction using discovery, expository, or a combination of these methods. Such labels as "guided discovery," "modified discovery," "semi-inductive discovery," and "inquiry learning" were often used in place of the term "discovery learning". Similarly, labels such as "lectures", "deductive learning," "teacher centered methods" and "authoritarianism" were frequently used as well as the term "expository learning."

In addition, as Wittrock (1966) points out, discovery as a METHOD of instruction is often confused with discovery as an OUTCOME of instruction; in other words, the desired outcome of being able to learn by discovery problem-solving techniques is sometimes confused with the instructional treatment used to produce other (content-specific) outcomes. Glaser (1966), in this connection, emphasizes that studies often don't clarify the difference between teaching specified obectives by a discovery method versus teaching for the objective of learning to make discoveries.

## Confouding with other components of instruction.

In addition to the problems of labeling instructional treatments discussed above, there also exists confounding of other variables with expository and discovery as methods of instruction. It is useful to analyze such general methods as discovery and expository as to the "strategy components" (such as rules, examples and practice) that make up each. Towards this end, it is useful to think in terms of four major types of methods of instruction (Reigeluth, 1979): (1) methods for organizing instruction , (2) methods for delivering instruction, (3) methods for motivating students, and (4) methods for managing instruction (see figure no. 1). Methods for organizing instruction cover strategies for selecting and sequencing elements of the instructional presentation. Delivery methods are concerned with how the instruction is conveyed to the learner, such as books, lecture, films and so on. Methods for motivating students include strategies for arousing and maintaining attention, making the instruction relevant for the student, building self-confidence in the learner, and furnishing appropriate rewards.

In addition, a category closely related to the organization of instruction is that of cognitive learning theory. Expository and discovery methods deal only with methods for organizing instruction; they specify the type of presentation forms (rules, examples and practice) to be used, and the sequencing of those presentation forms (e.g., example-rule versus rule-example). Nevertheless, people have frequently varied one or more of the other three types of methods in both applied and research settings.

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Insert Figure 1 about here

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<u>Cognitive learning strategies</u>.

Many studies have treated cognitive strategies, such as inductive and deductive thinking, as methods of organizing instruction. However, some researchers (e.g., Wittrock, 1966, Strike, 1975 and Breaux, 1975) have urged that such strategies be viewed as different from expository and discovery methods of instruction. Traditionally, discovery methods were assumed to naturally proceed from the specific to the general, or from the concrete to the abstract, while expository methods were assumed to naturally follow a sequence from the general to the specific. However, as Wittrock (1966) points out, the discovery learner could just as well begin with discovering a higher order rule and then derive lower rules, thus moving from the general to the specific. And, according to Breaux (1975) expository methods could involve inductive reasoning that moves from lower order rules to a higher order rule.

Such a study was designed by Breaux (1975) who incorporated both types of reasoning strategies (inductive and deductive) with both types of instructional methods. Thus, both the expository group and the discovery group were

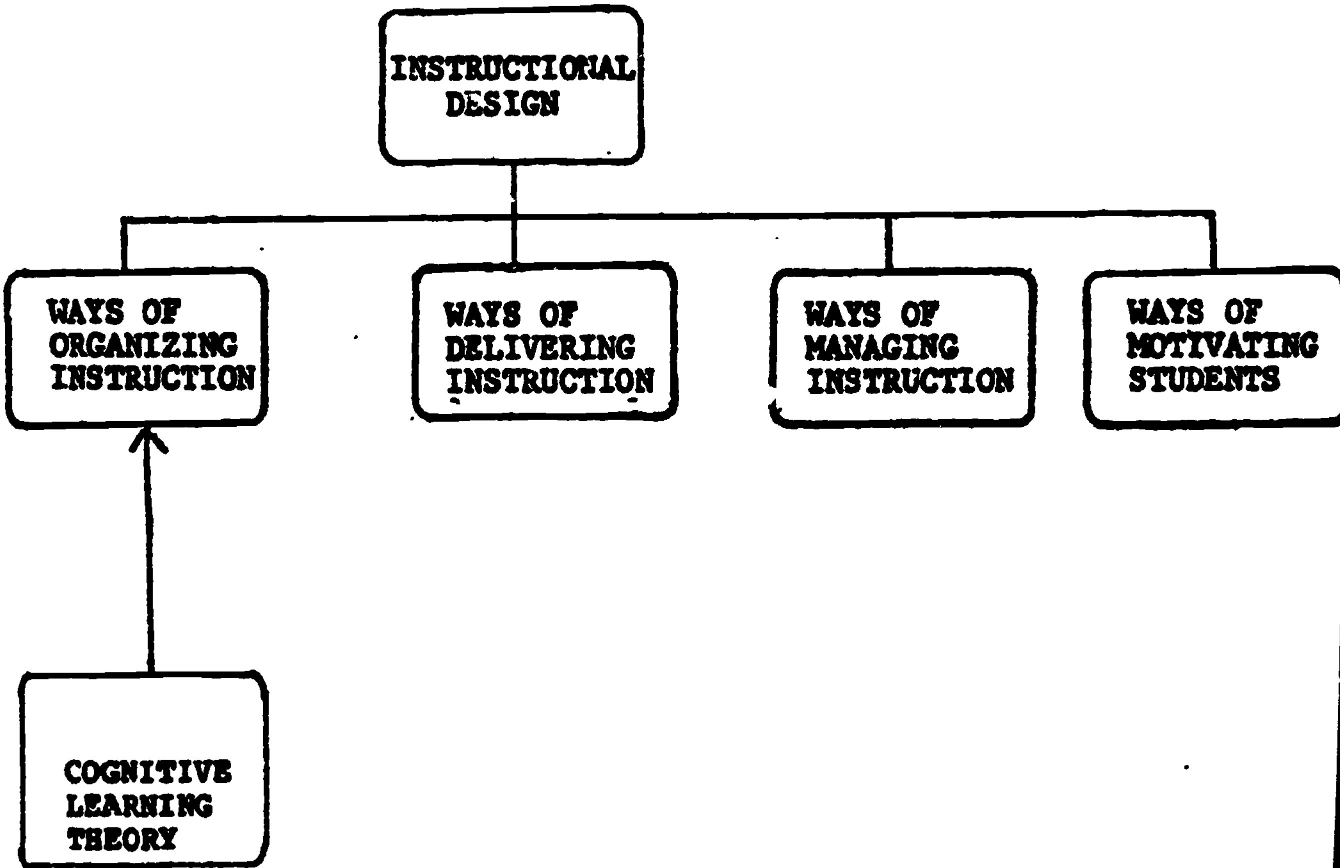


Figure 1. Four major types of methods of instruction. (Adapted from Reigeluth, 1979)

subdivided into inductive and deductive groups. Breaux found significant differences on a "transfer" test (which actually measured retention), and concluded that either type of reasoning strategy was indeed applicable to either type of instructional method and that the reasoning strategies did have an influence on the outcomes of instruction. He found significant it that the inductive expository group had the least errors on the posttest.

Delivery of instruction

As in the case of cognitive strategies, certain delivery strategies also tend to be associated with either discovery or expository instruction. Laboratory instruction, inquiry learning, the scientific method, and student-centered discussion are generally assumed to be characteristic of the discovery method. Other delivery strategies, such as lectures and teacher-centered discussion, are usually associated with the expository method.

Some researchers have taken exception to these associations and have conducted studies which utilized expository and discovery learning with delivery methods which were usually not associated found with them. Roughhead and Scandura (1962) designed a study in mathematics instruction in which one group received expository instruction in an inquiry mode, while another group received the expository instruction in a statement format. No significant differences were found between these two groups on tests of recall, retention or transfer.

Management of instruction

Labels such as authoritarian, democratic,and laissez-faire have sometimes been equated with either expository or discovery methods. For example, authoritarianism has often been associated with expository instruction (B.Keller, note 1). A study by Marchand (1975), describes the expository treatment of a course in music education as characterized by authoritarian teacher behaviors. An examination of these behaviors reveals that the teacher set instructional objectives, provided the content to be learned, drilled the learners on the learning tasks, and assessed the learner's performance. These behaviors could easily be applied to a discovery situation in which the teacher would (1) pose problems to be solved, (2) provide the examples to be used, (3) drill the learners on the solutions of the problems once found, and (4) assess the learners' performances.

Motivation of students

Some researchers (Kersh, 1962; Bruner, 1866; and Singer and Pease, 1976) believe that discovery methods probably encourage more learner involvement in active ways than expository methods do, and that this results in better motivation. Other researchers, however, have questioned the assumption that discovery methods are more motivating. Hermann (1969) points out that, although motivational effects were claimed in many of the studies he reviewed, no actual measures of motivation were taken. J. Keller (1979) has urged that measurement of effort, as distinct from learning and attitude, be used to better understand the motivational influences of particular instructional strategies. Yet, in her recent review of the literature, B. Keller (note 1) found no measures of effort used as indices of motivation; rather some studies employed measures of learner affect or attitudes toward the instructional situation in order to measure motivation. Recent work in motivating students suggests that motivational strategies designed to arouse curiosity, develop intrinsic satisfaction and self-competence, promote a sense of achievement, and stimulate active learner involvement can be used regardless of the specific type of instructional method used (for reviews see de Carms,1978; J. Keller, 1979)

## Component Display Theory as a Research Paradigm

Because discovery and expository methods are concerned with the selection of presentation forms and their sequencing, they belong in the category of organizational methods (Reigeluth, 1979), i.e. methods which are concerned with how instruction is organized and arranged for presentation. Merrill (in press) has developed a theory of the organization of instructon called Component Display Theory (CDT) which B. Keller (note 1) used to develop a method for analyzing the instructional treatments and tests used in expository-discovery studies, and this method was used as the basis, in the present study, for both constructing the instructional treatments and the posttest.

Merrill postulates that instructional presentations can include no more than three basic elements or forms — "primary presentation forms" — which may be selected and sequenced in a variety of ways when an instructional presentation is being organized. These primary presentation forms are: (1) a generality (or rule), (2) an example or examples, and (3) practice. The type of instructional method employed determines the selection and sequencing of the presentation forms. Thus, if the generality (rule) is explicity provided to the learner (no matter what delivery, management, motivational, or cognitive learning strategies are employed) the instruction should generally be considered expository. If the rule must be discovered by the learner (and is never presented), then the instruction is discovery; if, however, the rule is presented to the student <u>after</u> the student has discovered (or has been given time to discover) the rule, then the instruction is neither "pure" expository or discovery, but might be termed "modified discovery", since the student first has a chance to discover the rule, and then is explicity told the rule.

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(Insert Figure 2 about here)

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According to Merrill (in press), then, whether instruction is expository or discovery or a combination of these depends upon the type of primary presentation forms used in the instruction and their sequencing. B. Keller (note 1) found that there were many inconsistencies in what kind of instructonal treatments were called discovery or expository in past studies. In this study, then, one goal was to provide a clear, consistent definition of both expository and discovery methods and to compare the effectiveness of these different instructional treatments.

Merrill's CDT also specifies additional "secondary" presentation forms which have important effects on the primary presentation forms. These secondary presentation forms include helps or aids to both guide the learner and to stimulate better information processing. In some past studies, as Hermann (1969) notes, the amount of guidance (secondary presentation forms) provided influenced the nature of the instructional treatments in ways that confounded the distinctions between the various methods. Thus, in some studies, Hermann found that although a treatment might be termed discovery, the rule or generality had been verbalized aloud by the instructor at the end of the practice period and before the post-test. Others provided the rule after the recall test, but before a later transfer test.

Hermann (1969) also describes other confounding factors such as the amount of time given the student to learn, the number of examples provided, and the amount of activity in learning. Some studies allowed the discovery group to reach a specified criterion level on practice tasks, and then allowed them to continue to practice a specified number of times which corresponded to the number of practice items allowed for the expository group. Thus, the discovery group received, depending on the amount of practice items it took the subject to reach criterion, substantially more practice than the expository group. Hermann also found that some studies provided more examples for the discovery group, thus providing a richer instructional presentation than the expository students received. Another factor noted by Hermann was the amount of activity provided for the student in learning the material or task. In some cases discovery students were provided with more "hands on" or activity-oriented materials than expository students. Thus, controlling the secondary presentation forms could bring more consistency to comparisons of discovery and expository instructional treatments.

Component Display Theory also examines the task levels of the instruction, i.e. what the instruction require the students

*Expository*

Generality - Example - Practice

*Discovery*

Example - Practice

*Modified Discovery*

Example - Practice - Generality

Figure 2. The "primary presentation forms" and their sequence for each format of instruction.

to learn. Merrill specifies three task levels: (1) REMEMBERING a generality, (2) USING a generality, and (3) FINDING a generality. Obviously, in true discovery learning the students are always being asked to find a generality, and then are asked to use the generality and/or remember the generality. In true expository, however, the students are never asked to find a generality (it is always provided), but are asked to learn how to use the generality and/or remember it.

The notion of task levels is also useful in looking at the posttests that are given. A recall test is generally given immediately after instruction, and a so-called transfer test and/or a retention test later (B. Keller, note 1). In Keller's examination of past research, she found many inconsistencies both within and between studies in how the posttests were designed and administered. The instruction may have required the student to remember a generality, but the posttest might ask him/her to use a generality, for example. And the "transfer" test might simply ask the student to use the generality previously learned rather than to develop a new one. Also, inconsistencies between studies make it difficult to compare findings. For example, one study might teach the students to remember the generality, give a recall test on using the generality, and a transfer test on finding a related generality, while another study teaches the students how to use the generality, gives a recall test on remembering the generality, and a transfer test that asks the student to apply the generality already learned.

A final contribution of Component Display Theory involves the notion of content types. Merrill (date) specifies four types of content in instruction: (1)concept, (2) principle, (3) procedure, or (4) fact. B. Keller (note 1) found inconsistencies within studies on the content being presented for various treatment groups. Thus, a study by Solter (1978) which ostensibly taught preschoolers the concept of one-to-one correspondence, actually taught a concept to the expository group, a procedure to the discovery group, and a principle to a combination group. The notion of content type is also helpful in examining the posttests. The Solter study (1978) actually tested all three treatment groups on a procedure for the recall test, and on a concept for the far transfer test. Thus, using CDT can help researchers provide more consistency within a study, and alert us to both the similarities and the differences when making comparisons between studies.

The present study, therefore, was an effort to remendy the faults of some of the earlier studies by using CDT to design the instructional treatments and to construct the test.

Variables.

The independent variable, instructional organization, was divided into three treatments, based on Component Display Theory: (1) Expository, with the generality presented first, then the examples, and finally the practice tasks (G-E-P). (2) Modified Discovery, with the examples presented first, then the practice items, and finally, the generality (E-P-G). This group, therefore, was a combination of discovery and expository. (3) Discovery, with the examples presented first, and then the practice tasks. There would be no generality presented to this group at all. In addition to the three instructional treatments, a control treatment was given no instruction but did take the posttest.

The dependent variable was student performance scores on the posttest, which was composed of two subscales. The application subscale was designed to measure how well the student could use the generality presented in the lesson, while the transfer subscale measured how well the student could find new generalities related to the one used in the lesson.

Predictions.

The expository and modified discovery treatments, it was believed, would both do better than the discovey students since the discovery group would not have the extra enrichment so often provided in previous studies (Hermann, 1969; B. Keller, note 1.) and, it was thought, not do as well on the recall test.

Further, the modified discovery treatment was expected to stimulate any motivational properties that discovery might have (arouse curiosity, perhaps), and yet avoid the problem of the student failing to find the generality. Therefore, these students should do better than the expository students on the overall test. During the example presentations and the practice, these students would be trying to find the generality. At the end of instruction they would be told the rule, and would then find out if they had been successful.

Because the expository treatment students would receive the generality first, and, thus, be able to keep it in mind as the examples were presented and the practice tasks completed, it was believed that the expository students would do better than any other treatments on the application subscale of the test, since they presumably would have the generality firmly in mind.

Because the students in the modified discovery treatment were given the generality which could be used to confirm or correct their own interpretations of the rule to be used, it was believed that these students would do better on the application subscale than would the discovery students. The discovery students might find and learn an incorrect generality during their instruction, and thus, more students might perform poorly on the application segment of the posttest.

Further, it was believed that the students in the modified discovery treatment would have benefitted from the experience of trying to both find and use the generality during their instruction, and that they, therefore, would do better on the transfer subscale than the expository students.

Related to this notion, it was not expected that the modified discovery and discovery students would differ significantly on the transfer subscale, since they had both had instruction in finding a generality.

## Hypotheses

1. On the overall posttest (including both application and transfer items) the students in the modified discovery treatment will perform best, followed by the expository, discovery and control groups, in that order.

2. On the application subscale of the posttest the students in the expository treatment will perform best, followed by the modified discovery, discovery and control groups, in that order..

3. On the transfer subscale of the posttest the students in the modified discovery and discovery groups will perform better than the students in the expository and control groups, in that order )see Figure 3).

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Insert Figure 3 about here)

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# METHOD

## Design

A one-way analysis of variance with four groups (three experimental treatments and one control group) was chosen as the design since no interactional effects were hypothesized. Results were covaried, using Analysis of Co-varience, with student conceptual math aptitude scores achieved on the California Aptitude Test, which students had taken five months earlier.

## Subjects.

Fifty third graders from two suburban elementary schools outside of Syracuse, a medium-sized Northeastern city, were

1. Total Test: MD > E > D > C

2. Application: E > MD = D > C

3. Transfer: MD = D > E > C

Key: MD = Modified Discovery Treatment

E = Expository Treatment

D = Discovery Treatment

C = Control Treatment

Figure 3. Summary of Hypotheses

used in the study. All of the students present in the two third grade classrooms of one school, and all of the students present in one of the third grade classrooms plus ten from another third grade classroom in the other school participated in the study. The socio-economic status of most of the students ranged from middle to upper middle class, with 42% of the parents in professional and business occupations, 36% in blue collar occupations, 20% in semi-skilled jobs, and 2% unskilled. Racially, the areas were predominately white, with one school having 98% white students, and the other having 85% white students.

Third grade students were selected for two reasons. First, they were thought to be old enough for the experimenter to develop rapport with them fairly easily in a short time. Second, they had not yet reached an academic level that required involved generalities which could mean time-consuming example presentations and practice sessions. Since the experimenter would be individually instructing and testing each student, it was necessary to select subjects with whom a comfortable atomosphere could be quickly established, and whose instructional requirements could be encompassed within about thirty minutes.

The students were randomly assigned to one of four instructional treatments, and were then randomly scheduled during a three day period at each school. Because of unanticipated illness or absence from school, a sample of only fifty students was used.

Task and Materials

A concept taken from beginning set theory in conceptual mathematics, in a form suggesed in Attribute Games, was selected as the task. The concept was that a set is a group of objects that are all alike in someway, such as shape, color, or size.

This concept was chosen as the task for several reasons. First, a generality, examples, and practice items could easily be constructed using the booklet Attribute Games, compiled by Evelyn D. Marshall as a guide for teachers in teaching problem-solving and reasoning skills. Second, the content of such a lesson was checked with a third grade teacher who assured the experimenter that such a lesson was within the capabilities of the average third grader. Third, a third grade teacher from each of the participating schools said that the content of the lesson had not yet been taught to their students, but would be taught later in the year. Fourth, the experimenter felt that using math conceptual content would help to avoid biasing from either reading disabilities or computational disabilities that any of the students might have. And fifth, the experimenter felt that such a lesson could be presented using attribute blocks, which are both easy to manipulate and are inherently interesting to children of that age.

A set of attribute blocks were employed with every treatment group. The attribute blocks consist of sixty plastic blocks, each of which can best be described in terms of four attributes: shape, color, size, and thickness. The entire set contains: five shapes (square, circle, rectangle, triangle, and hexagon), three colors (red, yellow and blue), two sizes (small and large), and two thicknesses (thick and thin). No two blocks are alike in all four attributes, so that there is, for example, only ONE small thick blue rectangle, only ONE large thin yellow circle, and so on.

For this study only the thick blocks were used in the lesson so that the attributes of shape, size, and color were provided in examples and practice items, but not thickness. A listing of the type of blocks used in each component of instruction is provided below:

For the GENERALITY: No blocks were used in presenting this. The generality contained a simple statement of the rule to be learned, some elaboration on the rule, and, then, a restatement of the simple generality (see figure 4).

For the EXAMPLES: 1. Ten red blocks, both large and small, of circles, triangles, squares and rectangles.
2. Six circle blocks, both large and small of the colors red, blue and yellow.
3. Fifteen small blocks, of all three colors and all four shapes.
4. Six triangle blocks, both large and small, of all three colors.

For the PRACTICE: 1. Nine yellow blocks, consisting of both large and small, of the four shapes used.
2. Six square blocks, small and large, from all three colors.
3. Fifteen large blocks, of all three colors and all four shapes.
4. Six square blocks, both large and small, of all colors. 5. and 6. Twenty-four blocks of all shapes, colors, and sizes used previously.

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(Insert Figures 4, 5, and 6 about here)

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Instructional Treatments

The students were randomly assigned to one of four groups. Three of the groups received instructional treatments based on the three types of methods most commonly defined as expository, discovery, and a modification of discovery: (1) Generality-Example-Practice (expository treatment), (2) Example-Practice-Generality (modified discovery treatment), and (3) Example-Practice (discovery treatment). One generality, four examples, and six practice items were used whenever appropriate in a particular instructional treatment. Thus, except for the absence of any generality in the discovery treatment, all the components of instruction were identical for each instructional treatment; only the sequence differed. The fourth group was the Control group in which the students received no instruction. Students in all four treatments received the posttest immediately after the instruction or, in the case of the control group, after becoming acquainted with the experimenter.

Measures.

Two subscales comprised the posttest. The first subscale, application, consisted of four items in which the student was required to divide new objects into sets on any basis of their own choosing. In the first item, the student was asked to make a set using some tinkertoys, and was asked how it was made (on what basis). Then a set of the attribute blocks was provided, based on color, and the student was asked if it was a set and why or why not. The third and fourth items were similar, with one based on size and one on shape, both using attribute blocks. (See Figure 7.)

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(Insert Figure 7 about here)

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The second subscale, transfer, also consisted of four items, but these required the student to transfer the learning from the lesson to solve new tasks. That is, the student had to find new generalitiies similar to the one taught in the lesson, but different with respect to the attributes that can be used to form a set. The generality from the lesson was that a set is a group of things that are all alike in either color, size or shape. In the transfer subscale the student was presented first with a set based on thickness (which they had not been taught or given as an example), asked if it were a set and why or why not. This set employed only attribute blocks which the student had not seen previously. The other three items of the subscale consisted of sets based on substance (using a bowl, an animal figure, a game marker, and a spoon that were all made out of wood), kinds (using animal picture cards which could be grouped as either wild animals or as pets), and function (using string, rubber band, scotch tape, paper clips, safety pins which are all used to hold things together). Thus, the student was required to find and use four new generalities related to the one in the lesson. These new generalities were based on the idea that a set can be based on: (1) thickness, (2) substance, (3) kinds, and (4) function.

Procedures

All of the students were instructed individually by the experimenter in either a small conference room in the school library or in an isolated corner of the instructional resource room. At the beginning of the task, each student was told that the experimenter was trying to find out how children learned best, and that if they did the best they could, they would be helping the experimenter. They were also told that they would not receive a grade based on their time with the experimenter, but to relax and just do the best they could.

For the expository treatment the student first had the generality read to him or her, then saw four examples of the generality, and, finally, worked on six practice items. Corrective feedback was given during practice tasks, but the generality was never stated as a part of the feedback. When the lesson was finished (it usually took about twenty minutes) the student immediately took the posttest, also administered verbally by the experimenter.

The modified discovery treatment was administered in the same way, except that the student received the four examples first, then the six practice items, and, finally, the student had the generality read to him or her. Immediately afterward the student took the posttest.

The discovery treatment was also administered in the same way, except that these students received only the examples and practice items. These students did NOT have a generality read to them. They received the four examples first and then the six practice items, followed immediately by the posttest.

The control group was administered in the same way, except that they were given no instruction at all. Instead, these students chatted with the experimenter for about five minutes ( as was done with all the students in every treatment group to establish rapport), and then the post-test was administered. The time spent with the Control treatment students was usually about fifteen minutes in contrast to the half hour spent with students in the other treatment groups.

RESULTS

A one-way anaysis of variance for the overall posttest yielded an F ratio signifiant at the .0031 level of probability. For the application subscale the F ratio was signficant at the .0010 level, while for the transfer subscale the F ratio was significant at the .0312 level. (See Table I.)

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Insert Table I about here)

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The results were then covaried with student conceptual math aptitude, and no signifigance was found. Finally, the Duncan Procedure was used to determine which group means differed significantly. (See Tables II, III, and IV.)

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(Insert Tables II, III, and IV about here)

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1. Hypothesis #1, that the modified discovery group would perform best on the overall posttest, followed by the expository, the discovery and then the control group (MD > E > D > C) was only partially supported. All three of the treatment groups performed significantly better than the control group, but none of the instructional treatment groups performed significantly better than the others on the overall test. Thus, the equation can be written MD = E = D > C.

2. Hypothesis #2, that the students in the expository group would perform better than the other treatment groups (E > MD = D > C) on the application subscale also was only partially supported. Instead, the modified discovery treatment students performed significantly better than both the discovery and control groups, while the expository group was only significantly better than the control group and not significantly different from the discovery group. The equation, in this case, can be written E = MD > D > C.

3. Hypothesis #3, that the students in the modified discovery and discovery groups would perform significantly better on the transfer subscale than the other two groups, but would not differ significantly from each other (MD = D > E > C) was not supported. The discovery students performed significantly better than both the modified discovery and control groups, but not significantly better than the expository group. The expository group also performed significantly better than the modified dscovery and control groups, while the modified discovery group was only significantly better than the control group. Thus, the results show an equation of D = E > MD > C.

## DISCUSSION

HYPOTHESIS #1: It was reasoned that the modified discovery group would do the best because students would have the best of both types of instruction -- the motivational properties of discovery, and practice in both finding and using a generality, as well as the chance to correct any false rules they may have generated. While all three of the instructional treatments proved to be equally effective in facilitating performance on the overall posttest, a look at the means (see Table I) shows that the treatments which presented the generality (expository and modified discovery) both achieved higher means than the discovery group. Although this was not a significant difference, the number of subjects in each group was small, and it would be worth seeing if the expository and modified discovery groups would do significantly better on the overall test if the sample size were substantially increased.

HYPOTHESIS #2: While the expository group did not perform significantly better than the modified discovery group, it is interesting that both of these treatments, which received the generality, did significantly better on the application subscale than either the discovery treatment (without a generality provided) or the control group. This seems to indicate that explicit presentation of the rule facilitates application.

However, the fact that the expository students, did not do significantly better than the modified discovery group also deserves some comment. The expository group had the generality presented at the beginning of the lesson and were thought to have the best opportunity to learn to apply the rule. It may be that presenting the generality at the end of the lesson (as the modified discovery group had) emphasized it more in students' minds, and that this focused their attention on applying the rule. Here again, testing with a larger sample size might reveal some significant difference between the expository and modified discovery groups, which was not apparent with such a small sample size.

HYPOTHESIS #3: Contrary to the predictions, both the expository and discovery groups performed better on the transfer subscale than did the modified discovery students. While it was thought that the discovery group should do well on finding new rules (having just had practice in doing so), it was not expected that the expository group would also perform as well as on this subscale. It may be that presenting the generality at the beginning of the instruction focuses less attention on the specific rule to be used, so that by the time that the student encounters the transfer tasks, he or she easily generates related new rules.

A note of caution is necessary, however, in making this interpretation. The length of the generality provided in the instruction may have caused this effect. With a rather long generality to remember, the expository treatment may have more nearly approached the discovery treatment conditions, so that when viewing the examples and working on the practice items, these students may have been trying to find the generality, rather than remembering it.

The modified discovery group was expected to do well on the transfer items, but did significantly worse than the other two instructional treatments. It may be that the generality, placed at the end of the instruction, focused students' attention on the specific rule and on using it, rather than on how to find a new one, and, thus, the modified discovery students did not find new rules as easily. The discovery and expository students, however, did not have any such focus, but probably retained the emphasis on finding a generality (if in the discovery group), or had lost the focus on the generality presented at the beginning of the instruction (if in the expository group).

## CONCLUSIONS

While none of the instructional treatments proved to be significantly better on the overall test incorporating both application and transfer subscales, a few differences did emerge through analysis of the subscale results. The findings of this study seem to indicate that explicitly providing a generality, whether at the beginning or at the end of a lesson will facilitate performance on applying that generality. Further research with a larger sample size is needed to provide more information on whether there is any real difference on application learning if the generality is provided at the beginning or the end of the lesson.

In addition, finding a new generality on transfer items was facilitated by not having a generality at the end of the lesson. Thus, providing the rule at the beginning of instruction not only facilitated learning to apply the rule, but also seemed to help students learn to generate new rules related to the generality. This would seem to indicate that expository instruction can both improve performance on application tasks, and can also facilitate the ability to transfer learning by finding a new generality. However, in the present study, the generality provided for the expository students at the beginning of the lesson may not have been remembered clearly (due to its length) by the students as they experienced the instruction and took the posttest.

Further research is needed to investigate the results found in this study. Using a larger sample size would improve the power of the study, and providing a more succint generality might increase the chance of the generality having more effect in the expository treatment. However, it would also be useful to see if the present findings would be true for older students. Perhaps elementary school students, as these subjects were, react differently to the focusing effects of a generality at the end of a lesson than older students would. Or, older students might remember the generality better when its presented at the beginning of the lesson, benefit from having it in mind when viewing the examples and doing the pactice exercises. Perhaps, then, the effects of the generality would cause the expository instruction to significantly improve application of the rule, and would not facilitate finding new rules for transfer items.

Another factor to consider in interpreting these results concerns the context of the instructional situation. In this study, each student was instructed individually by the experimenter, but different effects might be found if the lesson had been presented to a class of students where group interaction might affect how well the rule is learned and how easily new rules are found.

One final consideration is the amount of time the students spent in the instruction. In this study, the students in the instructional treatments were instructed about twenty minutes each, and tested between five and ten minutes. If a longer lesson had been presented, or more lessons were given over a longer time period, the effcts might have been quite different.

Figure 4

INSTRUCTIONAL TREATMENTS

| COMPONENTS | EXPOSITORY | COMBINATION | DISCOVERY |
|---|---|---|---|
| 1. Primary Presentation Forms and Sequences | GEP | EPG | EP |
| a. # of examples | 4 | 4 | 4 |
| b. Performance Levels | UG | FG, UG | FG, UG |
| c. Content Type | Concept | Concept | Concept |
| 2. Practice | yes | yes | yes |
| a. Performance Level | UG | FG, UG | FG, UG |
| b. Content Type | Concept | Concept | Concept |
| c. Amount | 6 | 6 | 6 |
| 3. Secondary Presentation Forms | | | |
| a. Correct Answers | 6 | 6 | 6 |
| b. Types of practice materials | Blocks | Blocks | Blocks |
| 4. Outcomes Assessment | Total Test | App. Subscale | Transfer S[illegible] |
| a. Performance Level | FG, UG | UG | FG |
| b. Content Type | Concept | Concept | Concept |
| c. Delay Period | none | none | none |

Figure 4

GENERALITY

A set is a group of objects that are all alike in some way. The objects may be all the same shape, the same color, or the same size. These objects are the same in some way. If the objects are the same SHAPE, they could be triangles, circles, squares or a variety of other shapes. But they must ALL be the SAME shape in one set, if the set is based on shape. If you had a set of triangles you could not have a circle in it.

If the objects are the same COLOR, they could be blue, green, purple, or any color you can imagine. But they must ALL be the SAME color in one set, if the set is based on color. If you had a set of red objects you could not have a green object in it.

If the objects are the same SIZE, they could be large, medium, small, tiny, but they must ALL be the SAME size in one set if the set is based on size. If you had a set of small objects then you could not have a large object in it.

A set is a group of objects that are all alike in someway.

Figure 5

EXAMPLE

I'm going to put a set of blocks into the ring. This set is made up of red blocks. All of these blocks are red.

Now I'll make a different set in this ring. This time I'm going to make a set of cirlce blocks. These blocks are all circles.

Now I'll take these out and make a different set. This time I'm going to make a set of small blocks. All of these blocks are small.

Now I'll take these out, and make a different set. This time I'll make a set of traingles. All of these blocks are triangles.

Figure 6

PRACTICE

1. Now I'm going to make a set of blocks and I want you to tell me why it is a set. (Yellow blocks)
2. Repeat above using square blocks.
3. Repeat above using large blocks.
4. Repeat above using hexagon blocks.
5. Now you make a set of blocks. Make any kind of set that you want to make. How did you make it?
6. Repeat number 5.

Figure 7

POSTTEST

APPLICATION SUBSCALE

1. ←Make a set using the tinkertoys. How did you make it?
2. Is this a set? Why? (COLOR: Green objects from tinkertoys.)
3. ←Is this a set? Why? (SIZE: Large thick and thin blocks.)
4. Is this a set? Why? (SHAPE: Rectangluar blocks of all sizes and thicknesses.)

TRANSFER SUBSCALE

1. Is this a set? Why? (THICKNESS: Thin blocks of all colors, sizes and shapes.)
2. ←Is this a set? Why? (SUBSTANCE: Wooden objects).
3. Can you make a set from these pictures? If so, try to make it using at least four cards. How did you make it? (KINDS: Wild animals, pets, or furry mammals.)
4. Is this a set? Why? (FUNCTION: Objects that hold things together.)

TABLE I

GROUP MEANS, STANDARD DEVIATIONS AND F-VALUES

| Group | Number | Mean | Standard Deviation | F | p-vs |
| --- | --- | --- | --- | --- | --- |
| TOTAL TEST | | | | 5.34 | .001 |
| 1. Expository | 13 | 4.69 | 1.49 | | |
| 2. Modified Discovery | 13 | 4.76 | 1.79 | | |
| 3. Discovery | 14 | 4.50 | 1.74 | | |
| 4. Control | 10 | 2.3 | 1.64 | | |
| APPLICATION SUBSCALE | | | | 6.4 | .003 |
| 1. Expository | 13 | 3.00 | .91 | | |
| 2. Modified Discovery | 13 | 3.38 | .65 | | |
| 3. Discovery | 14 | 2.50 | 1.22 | | |
| 4. Control | 10 | 1.70 | .948 | | |
| TRANSFER SUBSCALE | | | | 3.22 | .03 |
| 1. Expository | 13 | 1.69 | 1.03 | | |
| 2. Modified Discovery | 13 | 1.39 | 1.39 | | |
| 3. Discovery | 14 | 2.00 | 1.04 | | |
| 4. Control | 10 | .60 | 1.20 | | |

TABLE II

DIFFERENCES AMONG THE MEANS FOR TOTAL TEST SCORES USING THE DUNCAN PROCEDURE[1]

| GROUP MEANS | C $\bar{X}_4$ | D $\bar{X}_3$ | MD $\bar{X}_2$ | E $\bar{X}_1$ |
|---|---|---|---|---|
| C $\bar{X}_4 = .80$ | - | 3.71* | 4.04* | 4.16* |
| D $\bar{X}_3 = 4.51$ | | - | .33 | .45 |
| MD $\bar{X}_2 = 4.84$ | | | - | .12 |
| E $\bar{X}_1 = 4.96$ | | | | - |

*$p < .05$

[1]Adjusted for conceptual math ability

TABLE III

DIFFERENCES AMONG THE MEANS FOR APPLICATION SUBSCALE SCORES USING THE DUNCAN PROCEDURE[1]

| GROUP MEANS | C $\bar{X}_4$ | D $\bar{X}_3$ | E $\bar{X}_1$ | MD $\bar{X}_2$ |
|---|---|---|---|---|
| C $\bar{X}_4 = 1.34$ | - | 1.17* | 1.84* | 2.23* |
| D $\bar{X}_3 = 2.51$ | | - | .67 | 1.06* |
| E $\bar{X}_1 = 3.18$ | | | - | .39 |
| MD $\bar{X}_2 = 3.57$ | | | | - |

*$p < .05$

[1]Adjusted for conceptual math ability

TABLE IV

DIFFERENCES AMONG THE MEANS FOR TRANSFER SUBSCALE SCORES USING THE DUNCAN PROCEDURE[1]

| GROUP MEANS | C $\bar{X}_4$ | MD $\bar{X}_2$ | E $\bar{X}_1$ | D $\bar{X}_3$ |
|---|---|---|---|---|
| C $\bar{X}_4 = .45$ | - | .82* | 1.32* | 1.56* |
| MD $\bar{X}_2 = 1.27$ | | - | .5* | .74* |
| E $\bar{X}_1 = 1.77$ | | | - | .24 |
| D $\bar{X}_3 = 2.01$ | | | | - |

*$p < .05$

[1]Adjusted for conceptual math ability

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