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ABSTRACT

The purpose of this report is to describe a systematic method of presenting a concept-learning problem to grade school children. Each child is tested individually. He is introduced to the concepts of size, shape, color, number of forms, and color of border on 2 by 3 inch cards in a practice book. He is then acquainted with a classificatory rule. Subsequently, the child is shown a combination of two concepts and then of three. When he has responded correctly to these, he is presented with the concept-learning task which follows the practice problems. The concept-learning task has been very successful with fifth and sixth grade children for whom concepts of this kind are difficult. The conventions used in presenting this task may be modified to suit the requirements of a particular experiment. This system should prove useful in studies of learning in which the primary interest is the way the subject processes information during learning. (Author/KJ)

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A SYSTEM FOR THE PRESENTATION OF A CONCEPT-LEARNING PROBLEM TO FIFTH- AND SIXTH-GRADE CHILDREN

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FOR RESEARCH AND DEVELOPMENT
IN TEACHING

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Preface

Since much research in education is concerned with concept learning, there is need for a systematic method of presenting concept-learning problems to children. In developing his Stanford dissertation, the author of this paper devised such a system in collaboration with me. The methodology described here has proved useful in the project on Uncertainty Studies conducted by the Stanford Center for Research and Development in Teaching, and is presented as having potential interest for other researchers.

Joan E. Sieber

A SYSTEM FOR THE PRESENTATION OF A CONCEPT-LEARNING PROBLEM TO FIFTH- AND SIXTH-GRADE CHILDREN

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This report describes a procedure and materials necessary to present a concept-learning problem to fifth- and sixth-grade children. The report has two parts. The first describes the practice problems, and the second, the learning problems. The technique was patterned after that used by Cahill and Hovland (1960) and by Bourne, Goldstein, and Lunk (1964). Cards to which geometrical figures were glued were presented to S, and S was required to verbalize his hypothesis.

Pilot study tests have indicated that concept problems of this type are extremely difficult for fifth- and sixth-graders. Ss were shown concept cards and asked to state rules about the ones that went together. Ss'usual response was to ask for clarification, or simply to state, "I don't understand." Attempts at verbal explanation did not solve their problem.

To overcome this difficulty, a set of practice problems was constructed. The principle used was simple--learning by example. Ss were shown cards with figures on them and asked to verbalize ways in which the cards were similar. After practice, E informed S that the verbal categories describing the similarities could be used to form the basis of rules that could be generalized to a broad set of stimuli.

Presentation of the materials in this manner met with immediate success. Ss no longer expressed confusion or asked for explanations; rather, the mean trials to criterion showed a sharp drop. Moreover, they expressed very little confusion with regard to the concept-learning task, and showed little hesitancy in stating verbal hypotheses.

At this point, the concept-learning system to be described has been used in three experiments. In the first (Paulson, 1969), a 2 x 3 factorial design was employed. The factors were Presentation (simultaneous or successive) and Level (one, two, or three). In the second (Sieber, Kameya, & Paulson, in press), the Level 1 problems were presented in simultaneous or successive presentation to anxious and nonanxious children. In a third study (Paulson, in preparation), the Level 1 and Level 3 problems were given to anxious and nonanxious children. Table 1 shows the mean trials to criterion in these studies.

TABLE 1

Mean Trials to Criterion
as a Function of Presentation Condition

	Presentation Condition					
	Simultaneous			Successive		
	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Paulson (1969)	2.62	8.32	11.74	4.72	12.49	11.31
Sieber, Kameya, and Paulson (in press)	3.23	-	-	7.73	-	-
Paulson (in preparation)	3.30	-	5.70	5.70	-	16.30

The following procedure was refined on the basis of tests given to several hundred children. The three sets of practice problems from the practice book are described first, followed by the concept-learning problem. A typed-pattern description of the practice book concludes the paper.

Practice Book

The materials used in the practice problems are mounted on 17 pages in a loose-leaf binder. A series of 2" x 3" white cards are placed four to eight to a page. The cards are outlined so that they stand out on the page.The cutout figures are mounted on each card, and each card forms one example of a concept.

The attributes are:

1. Size
   a. large (.75 inch)
   b. small (.37 inch)
2. Shape
   a. square
   b. triangle
3. Color
   a. brown
   b. black
4. Number of forms on card
   a. one
   b. two
5. Color of card border
   a. black
   b. red

A complete description of the arrangement of these attributes on each page of the practice book appears at the end of this report.

Each S is tested individually. Following an introductory statement (e.g., instruction specific to the experiment), S is introduced to the practice problem with the statement:

> Before we begin, we will do some practice so that you will understand what we want on the main problems. I will not keep score on the practice problems.

The first page of the practice book is then exposed, and the subject is told the following:

> On this page there are some cards. No two of these cards are alike, but there are ways in which they are similar. For instance, these two (indicating A and B, page 1) are similar because they both have brown on them. How are these two (C and D, page 1) similar?

The appropriate response is one that names the correct value of the relevant dimension. In this case, "color" is the relevant dimension and "black" the correct value. Therefore, the appropriate response is the word "black" (or a suitable substitute like "dark," etc.). E responds by saying:

> Yes, that is correct, they both have black on them.

If S does not respond, he may be prompted by noting that A and B both have brown on them. The question of how C and D are similar is then repeated. Additional prompts may be given when necessary.

When S has succeeded in classifying cards C and D, E selects a new stimulus dimension. E points to cards B and D and asks:

> How are these similar?

The appropriate response is judged to be one that contains the word "triangle." E responds:

> Yes, that is correct, they are both triangles.

The response "three corners" is acceptable, with S being told:

> That is correct. You can call them triangles. They all have triangles on them.

If S does not respond, or makes an irrelevant response, S is prompted by asking:

> Do you see some (other) way in which they go together?

If S still does not respond:

> Is there something about the shape of these (B and D) that is different from these (A and C)?

Additional prompts may be given in the rare instances where S has not produced an appropriate response. Once S has produced the response, "triangles," E then points to the two cards (A and C) that represent the alternate value of the shape dimension ("square"). When the appropriate response is selected, S is told: "Yes, they both have squares on them." S may be prompted if necessary.

The third stimulus dimension represented on the first page of the practice book is size. E first points to cards A and D and asks S how they go together. The size dimension is often a difficult one, with most Ss requiring one or more prompts. Prompting follows the pattern used above with one addition--cards B and C may be pointed out with S being told that they are different from the first two (A and D). Frequently, Ss will comment that they were not alike. If this occurs, E should agree that they look very different, but reaffirm that there is some way in which they are alike. If additional prompting is necessary, S may be told that B and C are "small": The appropriate response for cards A and D contained the word "large" or "big." When S has made an appropriate response, cards B and C are indicated and S is asked how they go together. Here, the appropriate response contains the words "small" or "little." Subjects may be prompted if necessary; however, the need is rare.

The Classificatory Rule

The concept of the classificatory rule is now introduced. This process involves relabeling the responses that S has already made. What has been called "a way in which cards go together" now becomes "the rule that they all fit." In both cases, the appropriate response is the name of the correct value of the relevant stimulus dimension. The following statement introduces the relabeling:

> I can say this another way. I can say that certain cards go together because they follow a certain rule. If I think of a rule that all browns go together, then these two cards (indicating A and B, page 1) fit the rule. As a matter of fact, any card that I might have had brown on would also fit the rule. Now, what rule would I be using if I said that these two (C and D) go together?

The appropriate response is "black" or "all blacks go together." If S fails to answer, or answers inappropriately, the following prompt is used:

> How did you say that they were similar? (S answers "black"). Yes, they are similar because they have black on them. Because they are similar in that they have black on them, then you can say that they follow the rule <u>all blacks go together</u>.

All pairs of cards that S had correctly classified as to similarity are now repeated. Each pair of cards is pointed out and E is asked:

> Can you think of a rule that makes these (indicating cards) go together? (S answers correctly). Yes,that is correct.

Note: Erroneous responses are extremely rare in this part of the practice problems.

Several conventions are employed when Ss state rules. If S verbalizes the dimension rather than the appropriate attribute (e.g., S says "size" rather than "large"), E corrects him by saying:

> Yes, they are different in size, but the size itself is important because later on when we start the main part of the test, the only answers I can score are those that actually say the correct word. These are the same (size), and that (size) is (large).

Before proceeding to the more complex problems, two additional one-level problems are presented from the second and third pages of the practice book. E indicates cards A and D of page 3, and asks:

> What rule would you use to group these two together?

If S replies that the rule was "twos" (an infrequent response), E replies:

> That is right, the rule is that twos go together.

A more frequent response to this problem is "square." When this is the case, E indicates card C and says:

> This card follows the rule "square" also. Can you think of a rule that would include only these cards (A and D) but exclude this one (C)?

If no response:

> How about how many there are?

When S produces the correct response, E replies:

> Yes, the rule is twos. If we use twos as the rule, then we can exclude this one (card C).

S is then asked to indicate on page 2 of the practice book which two cards also follow the rule twos (A and C). S is then asked to produce a classificatory rule to cards A and C on page 2. The rule is triangle. If S produces a different rule (one that does not exclude B or D), E requests another rule that would exclude B and D. The procedure used is patterned after that used above with the cards on page 3.

At this point E has the option of providing even more practice if it appears that S is experiencing difficulty with the task. Pages 4 and 5 of the practice book may be used may be used for this purpose, although additional practice of this type is rarely used.

Introduction of Two-Level Problems

After practice with one-level problems, the two-level problems are introduced:

> All right, I think you have the idea about what we want. Let's go on to the next type of problem. (Turning to first page of two-level practice problems). These problems are more complicated because they require rules that have two parts. The ones you just did required only one part to the rule . . .all triangles, or . . .all black . . .go together. The rules that fit the cards on this page require more complicated rules. The rules here have two parts. (Indicating the first column of the first page of two-level problems). All four of these cards have a rule on them. The same rule fits each one of the cards. (Indicating the second column). None of these cards have that rule on them. This rule has two parts. What is the rule?

The usual response to this question is that the rule is "black" or that it is "square." To this, E responds:

> Yes, they are all black (or square). However, look at what will happen if we use the rule black. All these cards (first column) fit the rule black, but so does this one (indicating card three in column two). Can you think of a second part of the rule that would exclude this black one? (If no response) Is there some other way in which they are all alike? . . . Is there something about their color (or shape)?

Additional prompts are given until S produces the required response.

In case S produces the correct response on the first trial (i.e., that they are all black squares), E responds:

> Yes, that is correct. There are two parts to the rule; they are all black and square.

Once S has produced the appropriate response, E explains how the rule black and square fits each card on the first page of two-level problems:

> OK, let's see how the rule black and square works out (indicating the bottom card in the far right column): This has the rule black and square on it. (Indicating the left column): None of the cards in this column has black squares. Some have squares but they are not black. Some are black but they are not square. But over here (indicating each card in left column) each has a black square in it.(Indicating a brown square): Why doesn't this fit the rule? (Response:--It is not black.) (Indicating a black triangle): Why doesn't this fit the rule? (Response: --It is not square.)

E then points to the second page of two-level concepts.

> What rule fits all of these cards (indicating left column) but does not fit any of these cards (indicating the column on the right). The rule has two parts.

When S gave the appropriate response (i.e., large triangles) E said:

> Yes, the rule is large triangles. Each of these cards (indicating) has large triangles on it. None of these (non-exemplars) have large triangles on them. Some are large. Some are triangles. But none are both large and triangle. The important thing to remember is that each of the rule cards has the rule on it. Each has large triangles. If I were to show you the cards one at a time, you could say large and triangle about each one of them. You wouldn't have to change any part of the rule. Later on, you will be seeing the cards one at a time.

In case S has difficulty in finding the rule, E prompts him by asking him to find one way in which all the positive exemplars are alike. After S has found a way, E asks him to find a second way in which they are alike. When S has found a second way, E asks him to state the two ways in which they are alike. S may experience difficulty with this process, and should be prompted several times if necessary in order for S to verbalize the two-part rule.

Page 8 is then exposed and S is asked to find the rule. Ss who have difficulty should be prompted by pointing out conflicting information among the negative exemplars. For example, if S states "small" as a rule, it is indicated that there is also a card with a small figure among the negative exemplars. He is then asked to find a more complicated rule that would exclude the small one. If S has difficulty finding the appropriate values of the dimensions, S is told to find ways the cards are alike, and if necessary, the name of the relevant dimension is mentioned (e.g., is there something about their color?).

Occasionally, S will name the dimension rather than the value. For example, S might say the rule is "color" when all exemplars were black. In this eventuality, E explains"

> Yes, they are all the same color. However, you must tell me the actual color because later on I will be keeping score, and I can give you credit only if you name the actual thing that makes up the rule. So tell me what the actual color is, not that they are the same color.

Frequently, Ss will group the four cards by pattern rather than similarity (e.g., on page 7, S might indicate the pattern: square-triangle-square-triangle). E's response in this case is:

> That is a way in which they are different. What we want is a way in which they are alike. If you have the correct rule, you can say the rule about each card. You can't use the rule (repeat of S's rule requiring two cards) about each individual card with the rule on it.

The remaining two-level problems are presented, with prompts when neeessary.

Introduction of Three-Level Problems

The practice book is now opened to page 12. S is told the following:

> We are now going to do some problems that are even more difficult. On the problems you just did, there were two parts to the rule. On these problems there are three parts to each rule. Also, there is a new part of the card that counts. On some, the edges are red and on some they are black.

The three-level problems are then presented. The same prompting and

correcting procedures are used that have been used with the two-level problems. Strong prompts are given with the first problem so that S will not become discouraged with the level of difficulty of the problems.

Concept-Learning Task

The concept-learning task follows the practice problems. The exemplars are assumed to be figures arranged in sucy a manner that they can be presented one at a time, for example, a deck of cards. Two forms of presentation are used: (a) cumulative presentation in which exemplars remain exposed after presentation, and (b) successive presentation in which each exemplar is removed before the next is presented.

The concept-learning task is introduced with the following instructions:

> Now we are going to do the main part of the testing. From now on I will keep score. I am going to show you cards just like we did on the practice problems. The only difference is that I will show them to you one at a time. I will ask you to guess the rule I am using to group the cards together. This is the same thing that we did in the practice book. The only difference is that you will see them one at a time.

Ss in the cumulative presentation are told:

> I will leave some of the cards out so that you will not have to remember so much. You can check back to remind yourself of what the earlier cards had on them.

Ss in the successive presentation are told:

> After I have shown you each card, I will take it away. You will have to remember what was on the earlier cards.

All Ss are then told:

> Do you remember that in the practice book some of the rules had one part, some had two parts and some had three parts? (E waits for an affirmative response, and if none is forthcoming, he opens the practice book and reminds S of examples of each level of solution.)

> The rule you are to guess now has (n) parts (where n = the number of levels of the concept problem to be presented). Remember that in the practice book, there were some rules that had (n) parts (the practice book is opened to an example of an (n) part rule).
>
> I will show you the cards one at a time, and I will tell you which cards fit and which do not fit the rule.
>
> Before we begin, let me show you some of the cards so that you will know the parts of the cards that count.

Several cards from the problem deck are then shown to the child, and then E asks S to verbalize all of the values of the dimensions represented on the cards. This procedure follows that of the "closed" system employed by Hovland (1952), Hovland and Weiss (1953), and Cahill and Hovland (1960) in that the universe of attributes and values were known to S at the beginning.

The exposed cards are then gathered up, and the following instructions are given:

> I will now show you the cards one at a time. I will tell you which cards fit the rule and which do not fit the rule. After you see each card with the rule, I want you to guess the rule. I will not tell you when you are correct; you will have to figure that out for yourself. Do you know how to tell when you are correct?(Here E pauses to allow S to consider the problem. Generally, S does not offer a solution). The way you will know that you have guessed the correct rule is that you never have to change any part of the rule. You will be able to keep guessing the same rule over and over, and it will always fit the cards with the rule. If you have to change any part of the rule, then you do not have the correct rule.
>
> Go ahead and start. You will catch on after you have done a few cards.

The cards are exposed to the child one at a time. Exposure time is difficult to control within narrow limits. Exposure from 10 to 20 seconds is recommended. Positive and negative exemplars may be presented alternately, and the series should begin with a positive exemplar. With each positive card, S is told:

> This card fits the rule. What do you think the rule is?

With each negative exemplar, S is told: "This card does not fit the rule." E records the hypothesis stated by S after each positive exemplar. S is not encouraged to state hypotheses after negative exemplars, and any hypotheses that are stated are not recorded.

E repeats S's statement, inserting the conjunction "and" between each part of the rule. This restatement is phrased in a standardized manner:

You think the rule is _____and_____and . . .(etc.)

Several conventions may be adopted to deal with problems that tend to arise.

If S states fewer than the required number of parts of the rule, he is told:

Remember, the rule has (n) parts.

If S states more than the requisite number of parts of the rule, he is told:

Remember, the rule has only (n) parts.

If the child begins to perseverate on an incorrect response (e.g., if size is an irrelevant dimension, a child may have guessed "large" and "small" alternatively), a fixed number of trials should be allowed to elapse, after which he is told:

> Remember, the same rule must fit all cards. You keep changing the rule by saying (e.g., large--small). You must find a rule that you never have to change. What part of the rule do you keep changing? (Pause, then hint).

If a child omits stating a particular dimension that is relevant to solution, he may be informed of this after a fixed number of trials elapses.

These conventions deal with problems that are likely to arise with some Ss. They may be modified to suit the requirements of a particular experiment. This system of presenting concept problems fo fifth- and sixth-graders should prove useful in studies of learning in which the primary interest is the way S processes information during learning. With modification, it should be applicable to a wide variety of learning research.

The typed-pattern description of the practice book follows.

Description of Practice Book

One-Level Concepts

Page 1

A. one
B. large
brown
square

B. one
small
brown
triangle

C. two
small
black
square

D. one
large
black
triangle

Page 2

A. two
small
brown
triangle

B. one
large
black
triangle

C. two
large
black
square

D. one
small
brown
square

Page 3

A. two
large
brown
square

B. one
small
brown
triangle

C. one
large
black
square

D. two
small
black
square

Page 4

A. two
large
black
triangle

B. two
small
black
triangle

C. two
large
brown
square

D. two
small
brown
square

One-Level Concepts (continued)

Page 5

A. one
small
brown
triangle

B. one
large
black
triangle

C. one
small
black
square

D. one
large
black
square

Two-Level Concepts

Page 6

A. one
large
black (x)
square (x)

B. one
large
brown
square

C. two
small
black
square

D. one
small
brown
triangle

E. one
small
black
square

F. two
large
black
triangle

G. two
large
black
square

H. one
small
brown
square

Two-Level Concepts (continued)

Page 7

A. two (x)
large (x)
brown
square

B. one
small
brown
triangle

C. two
large
brown
triangle

D. one
small
brown
square

E. two
large
black
square

F. one
large
black
square

G. two
large
black
triangle

H. two
small
black
triangle

Page 8

A. one
small (x)
brown (x)
square

B. one
small
black
square

C. two
small
brown
square

D. two
large
brown
square

E. two
small
brown
square

F. two
large
black
square

G. One
small
brown
triangle

H. one
large
brown
triangle

Two-Level Concepts (continued)

Page 9

A. two (x)
large
brown
triangle (x)

B. two
large
brown
square

C. two
small
black
triangle

D. one
large
black
triangle

E. two
large
brown
triangle

F. two
small
black
square

G. two
large
brown
triangle

H. one
large
brown
triangle

Page 10

A. one
large
black (x)
triangle (x)

B. one
small
brown
square

C. two
small
black
triangle

D. one
large
black
square

E. one
small
black
triangle

F. one
large
brown
triangle

G. one
small
black
triangle

H. one
small
brown
triangle

Two-Level Concepts (continued)

Page 11

A.
one
large
brown
triangle (x)

B.
one
large
brown
square

C.
two
large
black
triangle

D.
one
small
black
square

E.
two
large
brown
triangle

F.
two
small
black
triangle

G.
one
large
brown
triangle

H.
one
large
black
square

Three-Level Concepts

Page 12

A.
one
large
brown (x)
triangle (x)
black border (x)

B.
one
small
brown (x)
triangle (x)
black border (x)

C.
one
small
brown
triangle
black border

D.
two
small
brown
triangle
black border

E.
two
large
brown
triangle
black border

F.
one
large
brown
triangle
black border

G.
two
small
brown
triangle
black border

H.
two
large
brown
triangle
black border

Three-Level Concepts (continued)

Page 13

A. one
small
brown
triangle
red border

B. one
large
black
square
black border

C. one
large
black
triangle
black border

D. two
small
black
triangle
black border

E. one
large
brown
square
black border

F. one
small
black
square
red border

G. two
large
brown
triangle
red border

H. two
small
brown
triangle
red border

Page 14

A. one (x)
large
brown (x)
square (x)
red border

B. one (x)
small
brown (x)
square (x)
red border

C. one
small
brown
square
black border

D. one
large
brown
square
black border

E. one
large
brown
square
black border

F. one
large
brown
square
red border

G. one
small
brown
square
red border

H. one
small
brown
square
black border

Three-Level Concepts (continued)

Page 15

A.
one
large
black
triangle
red border

B.
two
large
brown
square
black border

C.
two
small
brown
square
red border

D.
one
large
brown
triangle
black border

E.
two
large
black
square
red border

F.
one
small
black
square
black border

G.
two
small
brown
square
black border

H.
one
small
black
triangle
black border

Page 16

A.
two (x)
large (x)
brown
square
red border

B.
two (x)
large (x)
brown
triangle
red border

C.
two
large
black
square
red border

D.
two
large
black
triangle
red border

E.
two
large
brown
red border

F.
two
large
black
red border

G.
two
large
black
square
red border

H.
two
large
black
triangle
red border

Three-Level Concept (continued)

Page 17

A. two
large
black
square
black border

B. two
small
brown
square
black border

C. two
large
brown
triangle
black border

D. two
small
black
square
red border

E. two
large
black
black border

F. one
large
black
red border

G. one
small
brown
triangle
black border

H. one
large
brown
square
black border

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