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Puzzle Analysis Handout

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Puzzle Analysis Handout

To give you some specific illustrations of how the reasoning patterns used by students can be related to Piaget's Theory we have prepared the following general analysis of responses to the puzzles in Module 1 and to the Frog Puzzle.

Mr. Short/ Mr. Tall Puzzle

Formal Reasoning (Type A). Each button corresponds to a certain number of paper clips, an intermediate quantity not stated in the puzzle nor asked for. Once this conversion ratio is known, the answer is found by multiplication. Alternatively, the student might conceptualize the height ratio, another intermediate abstraction, and then reason that this ratio must be invariant with respect to the units of measurement.

Concrete Reasoning (Type B). Since the height of Mr. Short measures more paper clips than buttons, simply add the extra amount to the height of Mr. Tall. Even though the arithmetic difference in units is not stated or asked for: it is a much more direct measure of the qualitative difference than is the ratio, which comes from making a correspondence between each individual button and paper clip. Another concrete approach make use of the height difference in buttons of the two figures, and associates that directly with the same difference in paper clips. Note that extra buttons are equated to extra paper clips, in contradiction to the fact that the four buttons measuring Mr. Short are equal to six and not four paper clips. This inconsistency is not noticed at the stage of concrete reasoning but would be noticed at the formal stage and would lead the students who had originally made this mistake to re-examine their procedures, to self-regulate.

Islands Puzzle

Formal Reasoning (Type A). On Question 2, the trip from Island B to Island C is conceptualized as possibly achieved by a change of planes or stop over at Island D. In other words, the clues about plane routes are not only evaluated in terms of the direct information they provide, but also in terms of the inferences that are possible by using the general rules about connections that were stated in the introduction of the puzzle. On Question 3, a student using reasoning can imagine all possible routes from Island A to Island C in order to bring to bear the information available in the clues. In particular, one must hypothesize that air travel is possible and evaluate this hypothesis for consistency with the data. Note that most of the Type A responses quoted in Module 1 did not make use of the formal approach to Question 3, but did on Question 2. This mixture of procedures is often observed in practice and indicates transitional reasoning, a reflection of the fact that the stages of Piaget's theory are idealizations which help one to classify observed behavior, but should not be used to classify people superficially.

Concrete reasoning (Type B). Since the clues do not give the answers to the questions directly, the concrete thinker either can't tell, selects certain details from the map (geographical placement, island separation) or postulates properties of each island to explain his ideas. The properties of a single island (size, topography) used in this approach are conceptually simpler to manipulate than the plane routes, which represent relationships between islands. This approach also eliminates the need to make use of the rules for combining plane routes.

Mealworm Puzzle

Formal Reasoning (Type A). Variables are held constant while only one is allowed to change. All possible causal factors are examined in turn to test the hypotheses that light or moisture or both are responsible for the distribution of the mealworms. The answer will be derived in a systematic manner with each possible conclusion being tested. Probabilistic reasoning is also evidenced by the student's ability to ignore the few mealworms in the "wrong" ends of boxes I, II, and IV.

Concrete Reasoning (Type B). An individual using concrete reasoning will fix on one variable to the exclusion of others. One does not detect the logic of the experiment which allows for variables to be separated and isolated, so that they can be dealt with as casual agents. One sees the one-to-one correspondence where one factor causes one response in one of the boxes.

Treasure Hunt Puzzle

Formal Reasoning (Type A). The student analyzes the problem as a combinatorial one. All the search parties are merely combinations of different characters from none, one alone, combinations of two, combinations of three, and one combination of four. The solution of all the possible (15) combinations (including none) is arrived at in a systematic way. Formal reasoning results in a tidiness, where combinations are not duplicated and are orderly arranged. Student reasoning in this way can generate all the possibilities. This is a hallmark of formal thought - one hypothesizes what could be instead of what is.

Concrete Reasoning (Type B). Combinations of character are generated by unsystematically and perhaps only in doubles and singles. Pieces of a combinatorial reasoning system are evident. However, the full system is not developed. This leads to an unsystematic and inexhaustive series of combinations.

Summary

Below is a chart in which we have applied the above considerations to the responses of six students who attempted the four puzzles in Module 1. In looking at these responses you can see that not one subject gave all formal responses. This indicates that students are at varying levels in various subject areas. We would not expect college students to think formally in every content area. The transition from concrete to formal thinking depends a great deal on the kinds of experiences that a person has had in a particular field of study. If students are a formal rather than a concrete reasoner in one area, however, they are more like to make the transition to formal reasoning in another area when they are given suitable intellectual stimulation.

College Students' Responses	Treasure Hunt	Mr. Short/ Mr. Tall	Islands	Mealworm
Delores Johnson (19)	C	Tr-F	Tr	F
Barbara Downing (21)	C	F	F	Tr
David Kenting (19)	C	C	Tr	F
Harold O'Keefe (20)	Tr	C	C	C
Norma Kuhn (20)	F	C	Tr	C
John Blake (16)	F	F	Tr	F

How does this compare with your classifications?

Please classify students' Frog Puzzle responses as directed on the next page.

Now we want you to classify the reasoning patterns your students used in solving the Frog Puzzle. Please try to keep your classification to four categories.

PC - Pre-concrete, acausal, whatever

C - Concrete

Tr - Transitional

F - Formal

After you have completed this task enter your results on the Frog Tally Chart. Below are some general comments that you may find helpful in your Frog Puzzle classification-of-responses activity.

Frog Puzzle

Concrete Reasoning. Differences are focused on rather than ratios. This student assumes constancy of differences and thus reasons as follows: there were 60 more unbanded frogs in the recapture sample, so there are 60 more frogs in the pond as a whole; 60 + 55 = 115. How would a person using concrete reasoning apply his reasoning to the following problem? "In a new recapture sample of 50 frogs, how many do you think are banded?" We have observed these response: (1) Impossible to do; (2) 10; and (3) -10!!

Formal Reasoning. Probabilistic reasoning is used. Starting with the relative frequency of banded frogs in the recapture sample, this student reasons that this ratio is an estimate of the relative frequency of banded frogs in the pond. After setting 12/72 equal to 55/x, the answer follows easily. This student is undisturbed by the uncertainty associated with a statistical estimate and realizes that, as an estimation, this procedure is valid.

When you have completed this activity, you are ready to go on to Module 3.