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Puzzles and Piaget

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PUZZLES AND PIAGET

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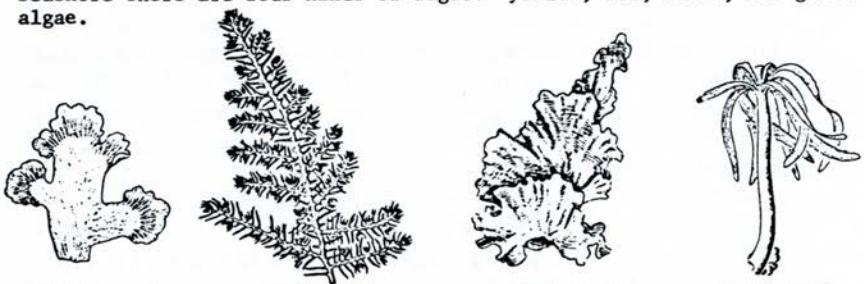
One important problem that all professional educators are confronted with everyday,is the question, "How does a teacher identify the functional basis of a student's learning problems?"

Personal experience has shown that student learning problems may often be analyzed intuitively and effectively through personal interviews. However, recent work by Anton Lawson and his colleagues at the University of California at Berkeley has produced a more analytical tool, based on Piagetian Reasoning Theory, to help educators understand how students operate mentally. This tool consists of a series of specially designed puzzles, the response to which, gives clues to understanding the functional basis for students' thought processes. As a biology teacher it has become a matter of considerable interest to me to understand how students reason in biological situations. With this in mind,I conducted an exploration into the functional basis of student thinking by using one of Lawson's puzzles (Fig. 1).

THE ALGAE PUZZLE

A population of crabs which eats algae lives on a seashore. On the seashore there are four kinds of algae: yellow, red, brown, and green algae.



Yellow -- Y **Red -- R** **Green -- G** **Brown -- B**

Dr. Saltspray, a biologist, is interested in determining which of the types of algae are actually eaten by the crabs. He plans to find out by examining the stomach contents of the crabs. Before he does his investigation he lists all the combinations of algae he thinks possible to find in the stomachs. Write down each possible combination of algae he can find. Use letters Y, R, G, and B to save space.

Figure 1

Procedure

With the permission of Dr. Lawson, the preceding puzzle was administered to 99 first-year, high school biology students. The students were distributed in two different school systems, one being urban and the other rural. Both schools had similar enrollments. Additional information was obtained concerning background, sex, age, and grade level. The responses were collected and tabulated. No attempt at this time has been made to correlate age, sex, grade level, or background with the types of responses given, since the main objective was to get a profile of student thought processes irrespective of other variables.

Results

Responses to the puzzle varied considerably, but four typical responses are given below:

Student A

Y. R, G, B, YR, YG, YB, RG, RB, GB,
YRG, YRB, YGB, RYG, RGB, YRGB.

Student B

YRGB, YRG, YR, YG, RG, YB, GB,
RB, Y, G, R.

The crab wouldn't eat brown algae alone. Bees will go to bright flowers and I think the crab will also. I doubt you will find brown algae in the crab unless it is with other algae.

Student C

YR, GB, RG, YG, YB, RB.

Student D

Yellow and green	Red and green
Yellow and red	Brown and red
Brown and yellow	Brown and green

Two fairly distinct approaches to the puzzle were observed in the study. For example, the responses of students A and B demonstrated a highly systematic and logically organized approach in obtaining their solutions. Although student B biased his thinking with an assumption which led him to a different solution, the reasoning is still clearly formal. Students C and D, on the other hand, used only the most obvious combinations, thereby demonstrating a lack of ability to develop a logic pattern which would more fully expose all possible relationships. If a student is utilizing only concrete approaches in the classroom, this may reflect on his or her ability to progress in problem solving situations. Student D may not have used symbols because of a difficulty with symbolic abstractions.

Discussion

Piaget defines *formal* reasoning as the ability to use objects in the development of hypotheses and the construction of relationships such as might be a part of the fundamental operations of elementary logic. On the other hand, he defines *concrete* reasoning as the ability to classify, order, ennumerate or associate objects (2).

A tabulation of student responses classified as *concrete* or *formal* is found in Table 1, for the students surveyed in this study.

Table 1

Comparative Problem Solving Approaches
in
Two Iowa High School Biology Classes

	Concrete Responses		Formal Responses		Total Responses	
Rural	12	20%	48	80%	60	100%
Urban	2	5.1%	37	94.9%	39	100%

It is interesting to note that the rural school had a larger proportion of students with a concrete pattern of thinking than those in the urban school. However, insufficient data were obtained to prove that this is a general phenomenon or only specific to the school systems involved or to the puzzle used in the study. Further studies are planned to explore this generalization.

One problem is significant with respect to the utilization of these puzzles. The specific content of each puzzle may be a limiting factor for some individuals or groups of individuals. If the specific organism is unfamiliar to a student, if the setting is unfamiliar to the student, or if quantities used are larger than may be comprehended, the use of the puzzle may be limited in the analysis of thought processes. Lawson does indicate his belief that in spite of these kinds of limitations, the puzzles do, "provide interesting information about student reasoning abilities and are probably reasonable first approximations of student differences." It would seem that these puzzles used with other classroom observations would be helpful in the identification of the functional basis of some learning problems. If you are interested in cooperating in a project utilizing these puzzles in your classroom, write David McCalley, Biology Department, University of Northern Iowa.

References

1. Lawson, A. E. and J. W. Renner. 1975. Piagetian theory and biology teaching. *The American Biology Teacher* 37(6):336.

2. Piaget, J. 1964. Development and learning. *Journal of Research in Science Teaching* 2(3):176.

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Man-Environment-Impact Conference

There will be an International Conference on Education and the Environment entitled, *Man-Environment-Impact*, on November 24-27, 1976 in Toronto, Ontario, Canada. The program will accent environmental applications of traditional disciplines in the secondary school curriculum. The program is co-sponsored by The Science Teachers Association of Ontario, The Ontario Association for Geographic and Environmental Education, the Environmental Science Teachers Association of Ontario, and the Council of Outdoor Educators of Ontario. For further information, write:

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One caterpillar said to another caterpillar while watching a passing butterfly, "You couldn't get me up in one of those things for a megabuck."