EDUCATION

Teach Logical Thinking

➤ SOME GENERALIZATIONS about logical thinking, similar in their usefulness but more advanced than "two plus two makes four," can be learned by high school science scholars through thinking experiences with puzzles, the 100th annual meeting of the National Academy of Sciences was told at Washington, D. C.

Dr. William Shockley, cowinner of the Nobel Prize in Physics for creation of the transistor at Bell Telephone Laboratories and now research director for Clevite Corporation's Shockley Laboratory in Palo Alto, Calif., presented his teaching approach, the objective of which is to develop comprehension of the essential features of a basic scientific principle or law in elementary terms by stating it as something which is "always true," "no matter what" the particular circumstances may be, "provided that" the basic conditions for the law to be applicable are not violated.

The qualifying phrases "no matter what" and "provided that" serve to convey the concept that a law has a certain range of validity; in a wide variety of cases it applies but there are usually limits which must not be exceeded.

Dr. Shockley illustrated his teaching approach by treating the answers to puzzles as simplified basic laws. The puzzles were presented with the aid of a projector and worked on by two high school juniors, David Agricola and Fredrick Walker, from Ohio.

Dr. Shockley suggested that learning these concepts at the junior high school level, or earlier, would make students more alert to recognize essential features of their scientific courses in high school and college, quicker to learn and better able to retain their knowledge.

He proposed that the concepts focused in the minds of the students by the three phrases, "always true," "no matter what" and "provided that," might constitute the most important mental tools for scientific thinking at the high school level.

He emphasized that research would be required to test the validity of his proposal but that there would be enormous value in finding the most useful mental tools for high school science students to develop. A particular example of these concepts is that it is always true that what goes up must come down no matter what solid body it is that goes up, provided that the solid body does not acquire enough speed to go into orbit. In this principle, the practical aspect of the "provided that" limit of validity was unimportant before 1957.

Dr. Shockley illustrated the puzzle solving approach in terms of Euler's problem, published in 1736, in which seven bridges over the Pregel River in Koenigsberg connect two islands to each shore. The problem is to take a walk in such a way as to cross each bridge once and only once. One island has three bridges, one to the other island and one to each shore; the other island has two bridges to each shore; and the problem cannot be solved.

The analysis of this problem illustrates the importance of three steps in problem solving: "familiarity" with the features of the situation, a "hunch" as to what the truth is, and finally "progress" to an ultimate answer by detailed analysis. The comprehension of the sequence "familiarity," "hunch" and "progress" is Dr. Shockley's proposed second most important mental tool for scientific thinking at the high school level. His third most important mental tool is the translation of quantitative physical reality into algebraic symbols and back again. He stated also that the practice of science is an art.

Dr. Shockley emphasized the very rewarding aspects of contributing to the learning of the eager, intelligent high school science students and expressed concern that our educational system so rarely gives these outstanding young minds intimate contact with the first-rate creators of new science.

• Science News Letter, 83:308 May 18, 1963

OCEANOGRAPHY

Middle-Depth Submarine For Ocean Studies

See Front Cover

➤ A MIDDLE-DEPTH submersible, or mesoscaph, for oceanographic studies is now under construction in Switzerland.

Designed and being constructed by oceanographer Dr. Jacques Piccard, the new vehicle will be unveiled next spring at the Swiss National Fair at Lausanne.

An artist's conception of this new submarine is seen on this week's front cover showing the ample window areas and undersea lighting facilities.

Dr. Piccard, who with his father, the late Prof. Auguste Piccard built and piloted the bathyscaph Trieste, said the steel hulled submarine will have a diving capability of 4,000 feet and considerable submerged maneuverability.

At the fair it will serve as a tourist submarine, carrying 40 passengers to the bottom of Lake Geneva, which has a maximum depth of 1,000 feet. At the close of the fair it will be offered to research groups for oceanographic observations and studies.

• Science News Letter, 83:308 May 18, 1963

Do You Know?

Greases which are not resistant to the action of powerful liquid fuels may react with rocket propellants to cause premature explosions.

By the year 2,000, 75% of all the *water* in rivers and streams will have to be withdrawn to meet the nation's needs compared with 25% today, unless water conservation technological changes are made.

• Science News Letter, 83:308 May 18, 1963

Questions

BACTERIOLOGY—On what do all living things in the sea depend for their food? p. 307.

GENERAL SCIENCE—What is the task of the effective teacher? p. 314.

GEOPHYSICS—How often do the whistling radio waves in space occur? p. 311.

MEDICINE—What anti-cancer drug has been successful in treating mycosis fungoides? p. 306.

SOCIOLOGY—How much has the number of illegitimate children increased in the United States since 1945? p. 309.

SPACE—How many pounds does Telstar II weigh? p. 310.

SCIENCE NEWS LETTER

VOL. 83 MAY 18, 1963 NO. 20

Edited by WATSON DAVIS

The Weekly Summary of Current Science, published every Saturday by SCIENCE SERVICE, Inc., 1719 N St., N.W., Washington 6, D. C., NOrth 7-2255. Cable Address: SCIENSERVC.

Subscription rates: 1 yr., $5.50; 2 yrs., $10.00; 3 yrs., $14.50; ten or more copies in one package to one address, 7½ cents per copy per week; single copy, 15 cents, more than six months old, 25 cents. No charge for foreign postage. Change of address: Three weeks notice is required. Please state exactly how magazine is addressed. Include postal zone number.

Printed in U.S.A. Second class postage paid at Washington, D. C. Established in mimeograph form March 13, 1922. Title registered as trademark, U.S. and Canadian Patent Offices. Indexed in Reader's Guide to Periodical Literature, Abridged Guide, and the Engineering Index. Member of Audit Bureau of Circulation.