GENERAL SCIENCE

Early Science Experiences

New information about potential scientists defines the types of encouragement effective at specific ages and underlines the importance of science teaching, Shirley Moore reports.

➤ FOR MORE AND BETTER future scientists, expose youngsters to effective science teaching and give them a chance to experiment in science themselves. And do it early.

This is the formula for improving America's future scientific manpower derived from studies of how children learn about science and how they are motivated.

The study, recently completed by Science Service, included 385 outstanding teen-aged scientists who were finalists at the 12th National Science Fair-International conducted by Science Service last May. Data collected on the age at which each finalist's interest originated were correlated with the factors reported to have stimulated this interest.

The study discovered a singularly high rate of momentum among 12-year-olds, nearly half of which was generated at school. The teachers of this seventh grade were responsible, as individuals, for setting in motion 30% of the finalists whose orientation began at this level, while class activities, special reports, individual and class projects, experiments and similar experiences at school motivated 10%. Courses in science and laboratory work focused the interest of 6.2% of these seventh grade starters.

Home environment and family activities provided the impetus for 17% of these 12-year-old potential scientists, and science fairs started 15%. Other influences included experience with scientific equipment, 9%; personal motivation, 5%; and scientists, medical doctors or technicians, 4%. Only one 12-year-old was inspired by reading and only one by activities in such organizations as Scouts and 4-H clubs.

During eighth and ninth grade, teachers wielded even a little more personal influence on their students' aspirations. The inspiring quality of activities and reports diminished, but science courses and laboratories were increasingly effective, propelling 23% of the eighth-grade starters and 25% of the ninth graders into their first real interest in science.

Family activities declined a little in importance during each of these years, as did the initial challenge of science fairs. Reading continued to be a negligible factor as an originator, while professional scientists inspired a slightly larger number of 13- and 14-year-olds than 12-year-olds.

Another unusual crest of original inclination was found at 10 years of age: 11% of the finalists. This is second only to the 12-year-old high point of 15%. This may have special significance for educators and parents searching for clues to the most effective kinds of encouragement and opportunity to offer.

A profile of the 10-year-old in the first flush of his science proclivity shows that he or she responded to stimuli somewhat different from those which inspired the 12-year-old beginners. School and home divided the honors at 10, with school sparking 27% and home 24%.

At school, the personal influence of the teacher stimulated only 16.6%, as compared with 30% in seventh grade; science courses and lab work drew in 5.9% as compared to 6.2%. Reports and class activities were responsible for only 4.7% in contrast to 10% at the 12-year-old level.

A 10-year-old apparently can be an outstanding success as a self-starter, for fully 19% of this age group generated their own impetus into science through a chronic itch to experiment and explore, or perhaps a natural propensity for meeting challenges head on. (In contrast, only 5% of the 12-year-old starters launched themselves.)

A chance to "fool around" with scientific equipment such as chemistry sets, radios, clocks and electric trains began the development of 14% of this age group. Books, magazines or other reading material started 7%, while the interest of another 7% was focused through activities such as science clubs, science fairs and junior museum groups. Astronomy programs and trips to observatories and planetariums were apparently noneffective at this age since only one 10-year-old starter reported this as a major influence. None of this group was motivated by professional scientists.

The very crucial importance of science teaching at such early age levels is shown by the fact that a surprising 44% of these promising young people dated the beginning of their intense interest in science between first grade and the time they entered junior high school or seventh grade.

A study of the sharp peak in the number of newly started pre-scientists which occurs at 10, normally fifth grade, may suggest ways of encouraging fourth and sixth grade students, who report relatively few first ventures into science.

More than a third of the finalists, 35%, found their enthusiasm aroused for the first time during junior high school years in seventh, eighth and ninth grades. The highest peak of all, 15% at 12 years of age, comes at the beginning of this particular period. Ninth grade, or 14 years of age, marked the origin of scientific bent for 10.6%, while eighth grade was not far behind with 9.6%.

Only 6% of the 376 finalists responding (nine did not know or did not state an age or grade) discovered the fascinations of science during senior high school when major science courses traditionally are introduced. The remaining 14% were "born scientists" or were already science-oriented before they became first graders. (For example, there is the lad who started his snail collection at three, affectionately storing his specimens in his bedroom—in one of his socks.)

Filling in a composite portrait of the very promising teen-aged scientist, sketched by

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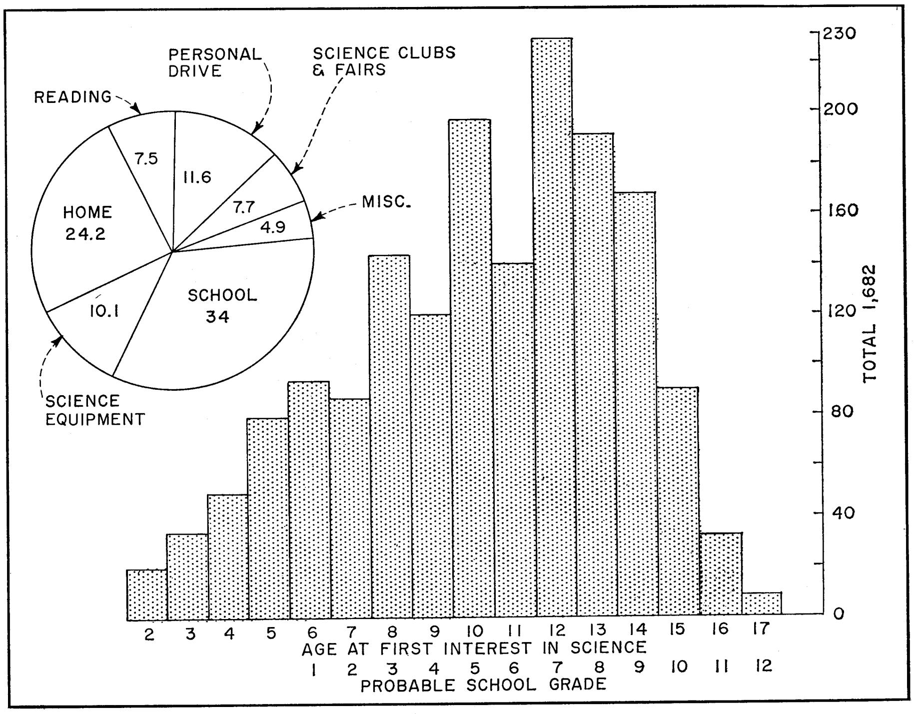

ORIGINS OF SCIENCE INTEREST—The ages and sources of interest in the sciences are shown in this graph of the results of a Science Service study of 1,682 finalists at National Science Fairs.

PRINCIPLES OF COLLEGE PHYSICS, Vols. I & II—George Shortley and Dudley Williams—*Prentice-Hall*, 3rd ed., 872 p., illus., $14.65. Suitable for students of both elementary and advanced backgrounds, stresses modern developments throughout.

PRINCIPLES OF NEURODYNAMICS: Perceptrons and the Theory of Brain Mechanisms—Frank Rosenblatt—*Spartan Bks*, 616 p., diagrams, $6.50. Sets forth the principles, motivations and accomplishments of the perceptron, a kind of brain model designed to determine the physical conditions of "natural intelligence."

PSYCHIATRY: Biological and Social—Ian Gregory—*Saunders*, 577 p., $10. Psychiatry for the non-specialist, outlining its principles and applying them to the diagnosis and treatment of neuroses met in practice.

RADIATION MEASUREMENTS OF THE EFFLUENT FROM THE KIWI-A SERIES OF REACTORS—H. S. Jordan—*Los Alamos Scientific Lab. (OTS)*, 128 p., illus., paper, $2.50. Data and hazard evaluations.

RESOURCE LITERATURE FOR SCIENCE TEACHERS—John S. Richardson, Ed.—*Ohio State Univ.*, rev. 2nd ed., 103 p., paper, $2.

SCIENCE AGAINST CANCER—Pat McGrady—*Public Affairs Committee*, Pamphlet No. 324, 20 p., illus., paper, 25¢ direct to publisher, 22 E. 38th St., New York 16, N. Y. A look at the progress made in the fight against cancer.

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the data collected from the finalists at the 12th National Science Fair-International, it is important to note that 31% of the 385 were girls and that the work of these young feminine scientists demonstrated a high level of ability and wide range of interest.

Professional goals among the scientific disciplines were designated by 95% of the finalists when they were asked to describe their plans for the future. Almost a quarter of them look forward to careers in the medical sciences, 18% in engineering, 16% in physics, 13% in biological sciences, 9% in teaching, 7% in chemistry, 4% in mathematics, and so on.

A whole world of facts, questions and ideas discovered in books, magazines, professional journals, scientific papers and science news reports served as the springboard for 35% of the ingenious and competent projects shown by the finalists at the National Fair. Individual curiosity, observations, experiences or problems inspired 16% of the exhibits, and 14% came from school courses, laboratory work, teachers' suggestions, activities or books available at school. Almost as many, 12%, were the outgrowth of earlier projects carried out by the finalists; 6% came from discussions with professional scientists. Science institutes and seminars supplied 4%. Other sources of stimulating ideas were science fairs, family and family friends, scientific laboratories, summer or part-time jobs in science, television programs, and Navy Science Cruises awarded the finalists for the excellence of their projects at earlier science fairs.

The backgrounds of these young men and women are varied, with 46.7% coming from homes where both parents continued their education beyond high school, 25.9% from homes where one parent has had some college training, and 27.5% from those where neither parent has had any advanced education. A total of 62.6% of their fathers attended college, with 40% attaining degrees (the degrees included 24 doctorates, five in medicine, eight in law, 31 master's and 81 bachelor's degrees.)

Some college background was reported for 56% of their mothers, and 26% earned degrees. Thirty-seven percent of their mothers are employed and, of those who work, 59% are professionally employed (39% as teachers); 37% work in clerical, sales or service jobs. Two mothers hold managerial positions, one works in a factory and one is a farmer.

The occupations of the fathers include 38% in the professions, 29% in clerical, sales and service positions, 16% in managerial or ownership categories, 7% in factory, construction or unskilled jobs and 6% in farming and ranching.

The 385 pre-scientists chosen to be finalists at the international event were selected by the judges of 200 cooperating fairs in 45 states, the District of Columbia, Puerto Rico, Germany-France-Italy, Japan, Canada and Thailand. These cooperating fairs, which exhibited some 68,000 projects to 1,760,000 visitors, were, in turn, supported by local school fairs with exhibits estimated to total more than three-quarters of a million. These projects were seen by nearly four million people.

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