Knowledge of science declines

As funds for science education, particularly for "science literacy," have decreased, more and more educators have expressed concern that budget cuts would inevitably be reflected in a decline in understanding of scientific matters among the mass of students (SN: 3/15/75, p. 169). Now a national survey indicates that, whatever the causes, just such a decline is taking place.

According to results just issued by the National Assessment of Educational Progress (NAEP), science achievement scores of American school children dropped two percent between the 1969-70 school year and 1972-73. The report concluded that the decline "would appear to correspond to the loss of a half year of learning experience."

Students in three age groups—9, 13 and 17—were asked questions considered appropriate to their education level, many dealing with health and other practical life situations (see box). Almost all areas showed a decline. In 1969, for example, nearly 85 percent of the 13-year-olds knew that malaria was carried by an insect, but in 1972, only 77 percent knew the correct answer.

About the only bright spot in the study was the discovery that rural students of all three age groups are beginning to catch up with students in suburban and city schools, though they remain below the national average. Suburban students still seem to be the best off, but their performance is declining at about the same rate as the national average. Inner city areas showed no improvement in scientific knowledge during the test period, despite enormous expenditures of money to improve educational conditions there.

Which of the following diseases is known to be transmitted by an insect?

- ☐ Cancer
- ☐ Diabetes
- ■ Malaria
- ☐ Polio
- ☐ I don't know.

Putting sand and salt together makes

- ☐ a chemical.
- ☐ a compound.
- ☐ an element.
- ■ a mixture.
- ☐ a solution.
- ☐ I don't know.

Sample question for 13-year-olds (top) and 9-year-olds (bottom).

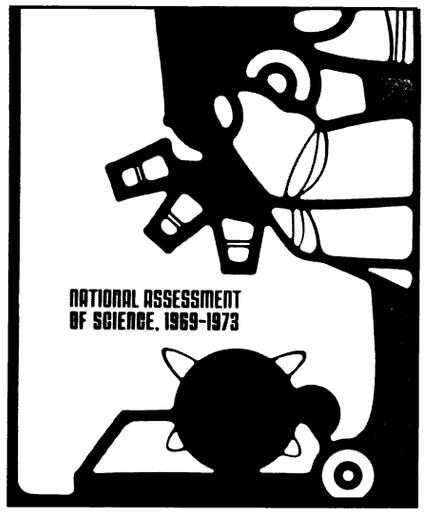
Boys still outperform girls, with the older students showing the greatest difference. The performance of 9-year-old boys was two to three percent above that of girls, and the gap increased to six percent by the end of high school. Black students remained about the same distance behind others during the three-year interval between tests, except for black 13-year-olds, who fell slightly further behind. Students from the Southeastern part of the country still do more poorly than the national average, but the gap narrowed slightly over the three-year period.

The report concludes that the decline in science achievement scores may simply reflect the fact that fewer students are electing to take science courses: "It is possible that achievement levels may be rising among those students enrolled in science curricula." Tests were given to all students, regardless of their formal contact with science, and the results reflect more a failure to prepare the future public to deal with technical matters than a failure to give future scientists a firm grounding in the fundamentals of their subject.

NAEP is conducted by the Education Commission of the States, a Denver-based organization which is conducting similar tests in fields other than science. Project Director J. Stanley Ahmann says the decline in science achievement may only represent a return to levels that prevailed before "unusual emphasis was given to science education in the wake of Sputnik. However, lower scores on several other national tests also suggest a general decline."

Concludes Ahmann: "This is a very poor time for such a decline, because our society is becoming more technological and complex. How can average citizens be expected to keep informed about critical social and environmental issues without a basic knowledge of science?"

Lowell J. Paige, National Science Foundation assistant director for education, says the figures indicating a decline of science achievement among students are probably correct, but that they "overstate the case a bit." The effect of new programs, recently initiated at the high school level to increase student interest in science, for example, would not yet be reflected in these statistics. Also, without knowing what sort of curriculum the students had been exposed to, evaluation of their interest in science would be difficult to make. "It's very difficult to know why student attitudes change toward science," Paige concludes; and despite the gloomy statistics, "students



seem to be going back into science. I'm not at all pessimistic about it."

Richard Trumbull, executive director of the American Institute of Biological Sciences, is concerned about the impact on future citizens. "This is no time for laymen to have less knowledge about a world that is becoming more technical," he says. Students should be taught about science as it applies to their daily lives—"it doesn't have to be a dry subject, just for specialists." □

Astronomy: Too attractive science

"Astronomy is everybody's second science." This oft-quoted phrase is used by Beverly Lynds of Kitt Peak National Observatory as an important reason for the dimensions of the current employment crisis in astronomy. The science is intellectually exciting, popular and attractive. It is relatively simple for persons trained in other branches of physical science to enter astronomy. It is relatively difficult for astronomers (their training tends to be narrow) to go into other branches. Twice as many enter as leave.

The figures are stark—a good deal worse than those for other sciences that are feeling the crunch. Four times as many astronomy Ph.D.'s are being graduated each year as there are positions to fill. In the next five years, it is estimated, 600 new doctors in astronomy will appear. Yet the same estimate gives only 50 to 100 expected openings by retirement and no more than 200 from all causes. There are now about 1,500 practicing astronomers in the United States. In 1970, 623 Ph.D.'s listed themselves as astronomers. The growth has come because of tremendous excitement in the field and because of the space program. But Federal funds for astronomical research, on which astronomy depends drastically,

have dropped. The wolf is at the observatory door.

The response of the astronomical establishment is unusually forthright. The National Academy of Sciences empaneled a committee of distinguished astronomers chaired by Leo Goldberg, director of Kitt Peak, to study the problem. The committee's main recommendation is blunt: Cut back severely on the number of new Ph.D.'s trained. Such recommendations have been privately made in other sciences and are probably being quietly acted on here and there, but official committees tend to gag on the taste of shell casing and they burble optimism even in hard times. The Astronomy Manpower Committee of the Committee on Science and Public Policy, as the NAS group is formally called, has gone so far as to draft a letter to prospective students laying out the prospects in all their grimness. Robert Kraft of the University of California at Santa Cruz, who is president of the American Astronomical Society, has mailed such a letter to the chairmen of graduate astronomy departments urging them to adopt something like it.

There seems to be general agreement that the number of new Ph.D.'s must be cut. Kraft indicates the debate is on the method. Some say raise the admission standards. Others say that's undemocratic—let them in and then be harsher with the marginal ones. But one way or another the number has to come down.

There is an optimistic side to the NAS recommendations. They urge changes in astronomical education to broaden employment opportunities for astronomers in industry and a redeployment of teaching astronomers to broaden opportunities in academia as well. Right now 50.8 percent of Ph.D. astronomers are in academic departments that offer the Ph.D., 12.3 percent in federally funded research centers, 17.7 percent in government and only 6.4 percent in industry. Thus most astronomers are engaged either in basic research or in training new astronomers or both. The NAS committee would like to see more astronomers in industry, and it would like to see more of them involving themselves with students who don't intend to become astronomers, by doing more undergraduate teaching, and especially by seeking positions in four-year and two-year colleges, where astronomy, if taught at all, is usually taught by a physics professor. (A physics professor often knows enough astronomy to teach an elementary course; an astronomer is often less versatile in the undergraduate physics courses remote from his specialty.)

The AAS has established a committee to see what can be done about all these possibilities and to see how astronomical curricula can be broadened to attract more students. Kraft stresses the cultural aspects of astronomy. "It has a lot of philosophical basis," he says. It's a good science to use as an exemplar, to show nonscientists what science is like and how it works. "Most people can understand what happens in astronomy; most people can't understand what happens in physics," Kraft points out. He also emphasizes astronomy's intimate connection with history and cultural trends. So the prescription seems to be: Down from the mountain and into the streets and the factories and the community colleges. □

Hair dyes: Do they or don't they?

Quite by accident, a University of California biochemist stumbled upon the somewhat ominous fact that most hair dyes can cause mutations in certain bacteria. The Berkeley professor is Bruce N. Ames, who developed some years ago a way of testing suspicious chemicals on sensitive strains of *Salmonella* to watch for mutations. The accident happened when he had his students bring in chemical products to test on the *Salmonella* system, and only one product, a hair dye, was strongly mutagenic. The implications of this accident and the research that followed would be profound—if they weren't so inconclusive.

After his suspicions were aroused by the positive finding, Ames and his colleagues tested 169 permanent and 25 semipermanent hair dyes in the bacterial assay system. He tested the dyes as they come out of the bottle, mixed with hydrogen peroxide, and 18 of the chemical components separately. He found that 150 of the permanent and most of the semipermanent dyes are mutagenic and that 9 of the 18 components are mutagenic. His work will appear in the April or May PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

There are two facts that lend dramatic overtones to his findings. First, Ames estimates that 70 to 75 percent of substances that are known carcinogens show up as mutagens in his *Salmonella* test. Second, 20 million Americans use $250 million worth of hair dyes each year.

Although the test results raise the specter of cancer and birth defect risks associated with the use of hair dyes, the results on bacteria fall far short of making such a connection. Ames's *Salmonella* system is now widely used to prescreen chemicals for possible biological effects, but it is extremely sensitive. And the links between mutagenic effects on bacteria bred without a cell wall and without normal DNA repair mechanisms and carcinogenic effects in higher organisms is quite tenuous and still unproven.

The findings, however, have put the cosmetic industry and its regulator, the Food and Drug Administration, on the defensive. There are no regulations that force cosmetics manufacturers to prove their products safe before marketing them. But most of the big firms have done extensive testing of hair dyes and report no evidence of cancer or birth defects in higher animals. The FDA, because of the lack of preregulatory authority, is put in the position of proving a cosmetic dangerous if a warning flag is raised. So after Ames's accidental finding last year, Herbert Blumenthal, Sidney Greene and colleagues at the FDA's Division of Toxicology, repeated Ames's test on some hair dye components. They confirmed his results on *Salmonella*, but have found no mutagenesis in yeast or fruit flies. They are working in cooperation with researchers at the National Cancer Institute and the National Institute of Environmental Health Sciences who are looking for mutagenic and carcinogenic effects in higher organisms.

It is unlikely that anyone will look upon Ames's work as an indictment of hair dyes—Ames least of all. But the work has, in Greene's words, pointed out a potential problem and has caused sufficient concern that Government, and industry scientists will take a closer look at these widely used cosmetics and at others containing chemicals with similar structures. □

No additional psi's?

Last November physicists discovered two new, unusual, extraheavy particles designated either J or psi(3105) and psi(3700) depending on which discoverers' terminology you adopt. [The latter has now been refined to psi(3695).] The new particles are raising an unprecedented storm of theoretical opinion, and the burning experimental question could be summed up in the old Hollywood cliche: "Are there any more like you at home?" The answer, according to a group of 34 experimenters from the Stanford Linear Accelerator Center and the Lawrence Berkeley Laboratory, is no, none for a fairly long stretch of mass up to 5.9 billion electron-volts, or about 1½ times the mass of the heavier of the two known ones. The physicists used SLAC's SPEAR storage ring to find out. Still there's a hope for yet higher energies, and the SLAC-LBL group intends to go on, raising SPEAR's energy step by step. □