Engineering Manpower

The Office of Education figures (News and Comment, 11 Feb., p. 667) projecting the number of engineering degrees to be awarded in 1970 and 1975 seem to me to be very unrealistic in view of the actual figures given for 1960 and 1965. The increase in percentage of high school graduates going on for advanced education has resulted in few additional engineering students. (This is even more evident from a table in the February issue of the *Journal of Engineering Education*, which shows the number of bachelor's, master's, and doctor's degrees awarded in 1949–65.) In fact, the gain that would be expected from the general increase has not materialized because more students capable of engineering studies have gone the route of pure science.

The large gain of 72 percent in M.S. graduates that occurred in engineering between 1960 and 1965 was accomplished with essentially no increase in B.S. graduates. Thus the ratio of one M.S. to three B.S. students represents a saturation ratio; few additional students would be qualified for advanced study. Therefore in the projection for 1970 of a 13,000 increase in B.S. graduates accompanied by a 9500 gain in M.S. graduates, both figures appear unreasonable. The ratio of M.S. to B.S. graduates is projected as 44 percent. This is much too high unless the standards of the M.S. program are lowered significantly or a much better quality of students suddenly appears on the scene. In my opinion neither of these situations is likely. Moreover, the influx of federal funds in the past several years has produced a large change in the number of engineering graduate students that the universities have been able to accommodate mainly because the relative efficiency of the total engineering effort has been significantly improved by utilizing unused capacity and by redirection of efforts toward graduate work. In the future, however, the slope of this curve will be flattened considerably as the total cost of any gains must be fully met with increased funds. In fact it is not at all apparent that, even if the money for such an escalation in graduate enrollment were forthcoming, the engineering departments of the universities would be able to find enough qualified personnel to man the programs, especially those for the Ph.D. . . .

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Elementary Science: "Content" or "Process"?

Commenting (Letters, 4 Mar.) on a new program of elementary science instruction described by R. M. Gagné (7 Jan., p. 49), J. M. Atkin, by repeatedly applying the unfortunate term "skills," gives a pejorative coloration to the elements of scientific activity which the program is designed to teach —observation, measurement, classification, interpreting data, inference, and formulating hypotheses. Atkin infers that the educators derived this list from an analysis of science by scientists, and he remarks that scientists are not particularly qualified "to characterize scientific activity." He offers that observation in support of an argument favoring "content" over "process" in grade school teaching of science.

Atkin asserts that while scientists "often measure, and they sometimes hypothesize, and they always make inferences," they don't usually study how to do these things "in some abstract fashion preparatory to conducting research." Why not? Is there reason to believe that a deep and broad understanding of these elements of sciences would not be fruitful to scientists? And what about a meaningful characterization of *cause* and *effect* and *evidence* in science? Obviously such concepts cannot be studied independently of examples, but is it correct to imply that they differ so much from field to field that they can safely be neglected in school?

Atkin claims that a "content" approach will provide children with a few fundamental principles without the risk of mastering "abstracted processes which may not, *on further analysis*, turn out to reflect accurately the nature of scientific inquiry" (italics added). If this point of view underlies the Elementary-School Science Project, which Atkin is presumably defending, I am worried about what may emerge from it.

A few years ago, would not "fundamental principles" have included the conservation of parity and the inability of certain gases to form compounds? Is it not time for the "further analysis" of the nature of scientific inquiry? Perhaps the revamping of secondary school science education should await the outcome.

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