Weaver is overly optimistic in his opinion that "the only useful judgment concerning university teachers comes from their immediate working colleagues."

It is very likely that no teacher is the best possible one for all his students and that no teacher is totally ineffective for all the students he teaches. Between these extremes, however, it should be possible to devise a comprehensive scheme of evaluation that can be accepted ultimately by a reasonable proportion of those interested in developing such a measure. . . . I would give greater weight than Weaver to students' judgments. . . .

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. . . It seems fruitless to discuss sources of evaluating teachers without establishing criteria for judging a good teacher. Having taught at various levels for 22 years, I am convinced that there are four basic criteria for good teachers.

1) Competence in subject field. A good teacher should be proficient not only in the subject matter he teaches, but also in related subjects, regarding teaching not as a routine duty but as a challenge requiring constant revitalization. He must be alert and diligent in searching both old and new knowledge.

2) Clarity of verbal communication. Instructions must be presented in such a way that the majority of students in the class comprehend and respond. Scholars with difficulty in verbal presentation can be great masters for a few graduate students though they may not be good teachers for most undergraduates. A seriously devoted teacher can improve his deficiencies in verbal communication.

3) Dedication to the educating process. The genuinely dedicated teacher recognizes that good teaching inspires results which sometimes don't become apparent for years, even decades, yet he finds such long-range opportunities continually challenging.

4) Love for students. Disinterest in one's pupils is not characteristic of good teachers who realize that their concern for individual students is an essential of teaching and the cultivation of wholesome citizens. Even in large classes, frequent contacts should be arranged to emphasize the personal relationship between teacher and students.

In summary, the first two criteria are objective and can be learned by any devoted teachers; the last two are subjective and must be acquired by self-discipline. Only when a teacher meets these criteria to a marked degree can he then be considered a good teacher. . . .

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The First Computers

Luther Carter, in his article on "Campus computers" (News and Comment, 25 Feb., p. 969), repeats a common error about the early history of computers, in saying that "the first computers were conceived and built at universities."

In the present context, I assume the term "computer" refers to the typical modern computer which differs from those of an older vintage in several ways. Probably the outstanding differences are in the programmed control and in the use of fast binary components.

In point of fact, there were in daily operation several computers with these characteristics some years prior to any completed in a university. The use of binary logic (with the excess-three code, now familiar to computer technology) was introduced in a computer designed by me and built at the Bell Telephone Laboratories in the period 1937–1939. It was demonstrated by remote control from Hanover, New Hampshire, at a meeting of the Mathematical Society in September 1940. . . .

The first operating computer in a university might be said to be the Harvard Mark I, of 1944. This machine was a decimal rather than a binary device and employed IBM mechanical drum accumulators. The first university-originated binary computers would, I think, be the Mark II and the ENIAC, both of about 1946. . . .

I should mention, too, that Konrad Zuse in Germany also made use of binary elements prior to the university-originated computers.

Perhaps, in view of the work of many pioneers like Aiken, Mauchly, Eckert, Williams, Andrews, Booth, and hundreds of others, it is unfair to name any particular computer as "first," but in recognition of the continuity of circuit logic from 1937 down to the present time, it seems that the early "relay" computers should be included among the pioneers.

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Industry Does Retrieve Information

Fry has presented an interesting mathematical expression for the relationships of information and research (Letters, 24 June). He states: "It often takes less time to do it all over again than to find out how someone did it earlier. This is, in fact, common practice in industrial research. . . ." This is far from the case in the pharmaceutical industry. The economic consequence of spending millions of dollars on a new product, only to learn that it is unpatentable because of the existence of prior art, would be so disastrous that no research group in their right minds would knowingly take such risks. In fact, we devote considerable time and expert attention to literature searching and, from personal experience in both academic and industrial spheres, I would say that the literature is searched more broadly and in greater depth in industry than in the academic world.

In part the difference in searching efficiency in industry is due to the large files that can be searched by computer, particularly in the patent area. Any deficiencies in our literature searching performance are certainly not due to lack of trying.

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New Channels for Grants

Recent discussions about the merits of project research grants over institutional grants have failed to mention one remedy that would overcome the disadvantages of institutional grants. As Gross points out (Letters, 6 May), senior administrators of institutional grants are tempted to divert most of the awarded funds to projects which happen to interest them. Though usually retired from active investigation, they continue naturally to have their favorite ideas about what is important to investigate. They are, moreover, under other pressures to build up this or that department or project in order to please or appease critics of their institutions.

The remedy which I propose resembles a water irrigation system. In such a system, each sluice gate diverts water while allowing other water to pass on to a lower level. In application of this principle, let us imagine agency A capable of disposing of so many funds for research. Suppose that this agency divides its funds into two portions. One portion will continue to support project grants directly applied for by the individual investigators or teams; the other will be awarded to institutions directly. Institution X (for example, a School of Engineering or Medicine), then receives a substantial grant as its share of the funds devoted to institutional grants. Of this institutional grant, the dean (and his associated committee, if he has one), can retain half, but must pass on the other half to the chairmen of the different departments of the benefited school. The chairmen in turn can use half of what they receive, as they see fit, but again must disperse the other half to any applying investigator within the department. If a chairman found no individual applicant within his department, these funds would revert to the next higher level, the dean's committee. This would stimulate the chairman to find and appoint applicants likely to use the funds.

A method such as this would assure original individual investigators of some support in spite of opposition from senior committee members of the institution. At the same time, it would preserve the privileges and responsibilities of administrators in retaining control of major portions of funds. We all know the familiar predicament of original investigators whose applications for funds have been frustrated for years both by local committees at their institutions and national committees of fund-granting agencies. The local committees are usually composed of persons outside the investigator's specialty who are not in a position to judge the value of an investigator's project or his abilities. But the outside committees, composed of scientists in the same field, often include many persons who have drifted out of active investigation themselves, while enjoying committee life. These persons often have clear ideas of where the next advances in their fields will come from and may prove equally frustrating to the origi-