or unaccompanied choir, the distinction between sharps and flats can be made, and is made by good performers. The distinction is not simply of mathematical interest; it is easily perceptible to a moderately good ear. While equal temperament is a necessary evil in keyboard instruments and has no doubt come to stay, there is no point in enforcing it where it is unnecessary.

(4) The key signatures are introduced for convenience, not to make the music look difficult. For example, in the key of D major the notes F♯ and C♯ are constantly recurring, while F♮ and C♮ occur only exceptionally. The regularity is therefore noted once and for all at the beginning of the piece, and only the exceptions are noted afterwards. If key signatures were abolished and all accidentals inserted every time they occurred, the exceptions to the general regularity would tend to get overlooked in the mass of accidentals. This applies particularly to music written in such keys as B major.

(5) If equal temperament were to be adopted for all music, it would no doubt be possible to eliminate the signs for sharps and flats by writing on a staff of seven lines and six spaces to the octave, and taking the interval between a line and an adjacent space to represent a tempered semitone. Experience has shown, however, that such large staffs are not easy to read, even for an experienced performer. The original Great Stave of eleven lines had to be divided into two by the omission of the middle line for this very reason.

(6) The present system is admittedly awkward for the notation of certain modern music not based on the diatonic scales. However, such music is not likely to be studied by a beginner, and, indeed, still forms only a small part of the repertory.

The initial difficulties of the musical notation are no greater than those which face the student of a new language or a new branch of mathematics. No real progress will be made by trying to evade them.

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[1] NATURE, 149, 554 (1942).

Science and Science Teaching

HAVING listened to the discussions opened by Prof. Lancelot Hogben and by Mr. L. J. F. Brimble, reported in a recent issue of NATURE[1], on the role of human applications in science teaching, it seems to me that something may be gained by examining, from a scientific point of view, the nature of science itself. Science, we are told, is a method of observation and classification of phenomena. But this is, metaphorically speaking, only its physiology. It has also an evolution and an ecology. How did it come into existence? In what surroundings does it flourish?

It is a sociological phenomenon, a function of human society, for every letter of it is the product of human minds working together, and of the fingers of more than one pair of hands. Moreover, it requires a certain state of social development before it can appear. During the greater part of the human era it has not existed; in some parts of the world it does not thrive to-day. The value of scientific method may seem as clear as noonday to us, but (taking samples of social life at random in space and time) this outlook has not been even the usual one.

Only in certain conditions has it been found 'paying' to use science, and therefore become customary to encourage it morally and financially. Only then has the germ of scientific method, always present in the human mind, made progress relative to other forms of mental activity. But in these circumstances science has 'paid' just because its findings proved true when put into *practice*. Its cultivation therefore depended on its verification, not 'in the test-tube' but 'in the works'. (This has extended recently to biology.) Here we have a two-way correlation between pure science and applied; neither can in fact exist without the other, like Newton's "action" and "reaction".

Until recently it has been customary, both in authoritative appraisement and in teaching, to exalt pure science and neglect the interrelationship. Now, questioning these preconceptions, we must teach science as a form of human activity, as mankind's struggle to master Nature (including his own), wherein 'pure' and 'applied' are seen as parts of one whole, the strategy and tactics of man's war against ignorance and impotence. All science is applied knowledge, but some parts (the 'pure') have a wider field of applicability than others. What is not (ultimately) applicable is not science.

The test of the truth of an expressed scientific principle does not lie only in some original investigation in the past; it is still being tested in the present in its practical applications. Therefore there is no particular scientific merit in always teaching the original experimental method by which the principle was derived, or in a 'laboratory' method of experimental proof. How then, it will be asked, are we to awaken and keep alive in our students the investigatory spirit? Partly by description and reproduction of a few selected historic investigations as striking examples of scientific method. But these must be part only of a general treatment showing science in all its parts as a live, present-day inquisitive and progressive movement of mankind, illustrating its principles not only by historic derivations, but also largely by simple (for children) modern applications. Occasional serious discussion of projected or suggested applications will help to emphasize the importance of research. It seems worthy of consideration, too, whether we cannot cut out traditional treatment of some older principles, replacing them by wider generalizations in which they are included. Experimental technique should be taught only when it can be made to answer a question of genuine interest to the student.

In recent discussions on science teaching much has been said of the conflicting interests of 'future specialist and future 'general citizen', of future academic scientist and future technician, of 'humanist' and 'scientist'. But if the methods sketched above can be brought more into use, the whole of science teaching will be made more 'live', by being brought more into contact with the fronts on which mankind is advancing, to the benefit of all the categories of students mentioned, and so of mankind in general.

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[1] NATURE, 149, 456, 447, 555 (1942).