course seek them. But his blame is not greater than that of other groups of people. He must take his share of the blame, but he is not a sinner above other men in this respect.

The engineer, with other folk, must come to recognize that while clearing the ground is an important and dignified part of the process of building the temple of society, and that while in dignity and worthiness it is second to no other task, yet the clearing of the ground does not insure that a beautiful temple will be built, and that emphasis must be placed on the proper use of the facilities he has helped create. In considering the proper use of the facilities made available by applied science—surely a field of study of vital importance to culture—the speaker believes that the engineer may well emphasize the necessity of giving due consideration to the viewpoint of the workaday world—not on emphasis which overshadows the viewpoint of the leisurely scholar who is freed from anxiety for daily bread, but an emphasis which will cause attention to be given to *both* viewpoints—a really broad-minded emphasis. He may well emphasize the engineer's idea of tolerance. Moreover he must avoid the great error, rather common to the artist type, of the tendency to see everything outside one's own field through a reversed telescope, as small and unimportant. As the engineer demands that the dignity of his work for humanity be recognized, he must be willing to give adequate recognition to the view-points of preachers and economists, artists, and philosophers, authors and pure scientists.

SCIENTIFIC AND PHILOSOPHICAL METHODS IN EDUCATION[1]

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THERE is precedent for the discussion of this topic before this association. Several years ago, Dr. Pechstein, the retiring vice-president, discussed the question, "Is there a science of education?" He presented the results of a questionnaire addressed to well-known students of the science of education. He left the impression that while education may not be classed as a science similar to physics, chemistry, biology or psychology, it may use scientific methods and hence may be regarded as an applied science similar to engineering or medicine. Perhaps scientific students of education will not quarrel about a name if it be admitted that the problems of education can be attacked by scientific methods. At the meeting a year ago, Dr. Kelley discussed a question which is somewhat more nearly related to the one we have before us at this meeting. He took as his specific problem the relation between science and philosophy as methods of study of educational problems. The solution which he offered was that both science and philosophy have a place in the study of education. The place of science is to determine the general principles which govern educational procedures and the place of philosophy is to deal with and to find the solution of particular or concrete issues. When the student of education formulates a general law or principle, then, he is scientific, but, when he faces a complex situation demanding that he decide what form of practical action should be taken, he has recourse to philosophy. Science is general, philosophy is particular; science is theoretical, philosophy is practical. We shall find in the course of our discussion that concepts of the nature of philosophy and of its applications in education are varied. This is one which we shall have to include in our list for consideration.

The existence of a precedent is perhaps hardly sufficient justification for discussing the relation between the philosophical and the scientific methods on the present occasion. It is true that the recognition of education as having a legitimate place in a scientific association immediately suggests the problem. It is also true that questions of method are quite appropriate for discussion in meetings at which scientists of various interests and types of training join together. But the subject has recently been discussed in other groups as well as in this one, and it may be thought to be a hackneyed question if not indeed an academic one. I believe, however, that the problem at issue merits some further consideration. The question may be hackneyed, but there is still a marked difference of opinion upon it. The philosophy of education is made a prominent part of the curriculum of some departments or schools of education and it is omitted as a distinct subject of instruction in others. A contrast between the philosophical and the scientific mode of approach is represented not only in courses of instruction but also in the thinking and

[1] Address of the retiring vice-president of Section Q—Education, American Association for the Advancement of Science, Cleveland, December 30, 1930.

the consequent practice of teachers and administrators in general. The issue cuts deeper than a mere theoretical or a verbal adherence to one or the other side of an academic issue. The philosophical and scientific methods are not merely complementary methods, the one suited to one type of situation and the other to another. They represent differences in emphasis which characterize different modes of approach to the same problem. One of these methods is, I believe, more productive than the other and more likely to lead to progressive improvement of educational practices. For these reasons it is worth while to continue the discussion of the problem.

We often speak of philosophy and science as though we all meant the same thing and knew exactly what we meant. As a matter of fact, neither of these assumptions is true. A great variety of things is meant by both philosophy and science, particularly as applied to education, and those who discuss the issue between these two methods very commonly do not recognize that they may be talking about quite different things. It will be worth while at the beginning, then, to run over some of the diverse conceptions of these two methods.

Conceptions of the meaning of philosophy as a method are probably more varied than are the conceptions of science, so we may begin with philosophy. Philosophy is sometimes used in a technical sense to designate a rather highly specialized discipline, having a long history and a definite field which it cultivates. This is the meaning which is attached to philosophy as a subject of study in universities. Certain parts of it are highly speculative. They are dealt with in *metaphysics* or the *theory of knowledge*. They are concerned with such questions as the ultimate nature of the universe or with the possibilities or limitations of our knowledge of reality. They deal with issues which divide philosophers into camps, such as the issue between realism and idealism. These and similar questions have divided philosophers for ages and seem likely to divide them for ages to come unless they turn their backs on the problems entirely and become pragmatists.

It is a little difficult to see how metaphysics or epistemology could have a direct bearing upon practical issues in education. In fact, it is difficult to see how they have a direct bearing on practical issues of any sort. The questions with which these disciplines deal are speculative and outside or beyond the realm of immediate experience. It is sometimes held that certain assumptions concerning the issues in metaphysics are necessary as a basis for the derivation of principles in the more practical discipline of ethics; but the modern treatment of ethics deals with it through a direct analysis of experience rather than through an appeal to speculative principles. This type of speculative philosophy is not widely represented among students of education and we may, therefore, dismiss it from further consideration.

It is rather a far call from philosophy of the type which has just been mentioned to philosophy as a settler of practical, concrete, immediate issues. It is rather difficult for one who is accustomed to thinking of philosophy as dealing with such problems as the nature of reality, the nature and existence of God, the possibility or necessity of freedom, or the possibility and limits of knowledge, to think of philosophy as represented in a process of deciding whether one should spend one's money to buy a new windmill or to send one's daughter to college, or again, whether one should accept a new job which offers novel attractions or remain in the old job and enjoy the advantages which are connected with it. This is quite a different meaning of the term, inconsistent with the first one. Philosophy, according to this usage, means weighing and balancing all the considerations on one side or the other of a practical issue and then throwing the weight of one's decision on the side which presents the greater advantages. The philosopher, according to this view, is not the absent-minded recluse sitting in his study and pondering the ultimate nature of the universe. The philosopher is rather the practical man of affairs; the administrator, a person of judgment and good sense who is able to make the right decision at the right time.

Lying back of this notion, apparently, is the view that the acquirement of an adequate philosophy will in some way give the individual such ability to weigh all the values of life that when a practical issue confronts him he will be able to refer to these values and thus find the decision as good as made for him. This is an alluring prospect, but it hardly seems borne out by the facts. The connection between the more abstract or speculative considerations and the practical ones which meet the individual in his daily life is after all a rather remote one. The illustrations of practical problems offered by proponents of philosophy as suitable for solution by the application of philosophical values have not usually been elaborated sufficiently to show in detail how these values may actually be applied to the solution of the problems in question. This conception of philosophy as a settler of practical issues, therefore, seems hardly to be a tenable one.

Another conception of philosophy regards it as a personal, individual reaction to the values or goods which are presented in life. Philosophy is the subjective aspect of one's reactions. A given person may like a thing or not like a thing, but there is no appeal beyond his taste. Another person disagrees

with him, but there is no common ground for discussion, much less of agreement. Each one's evaluation of his experiences is an ultimate, and there is no means of explaining it nor, as far as I can see, of changing it. This conception is sometimes put in physiological terms by saying that science is a product of the activity of the brain and central nervous system, while the philosophical attitudes or evaluations are the product of the autonomic system. These aspects of the world which one evaluates through this purely personal and individual mode of response can not, therefore, be studied scientifically, can not be subjected to the canons of right or wrong and can not be settled by majority vote.

This argument proves rather too much. If philosophy consists in attitudes which are so inaccessible to scientific study and are so subjective as to necessitate mere acceptance without evaluation by another person, this type of philosophy would deny the very root idea of philosophy itself, which is reasoned discussion. Such attitudes can form the basis for neither philosophy nor education. A category from which there is no appeal, either by scientific study or by reasoned discussion, could never serve as the basis for educational theory. Only a type of evaluation which gave some possibility of common agreement could ever furnish the basis for educational policy or procedure.

A more common conception regards philosophy as the determiner of ends or values and science in contrast as the determiner of means to the attainment of these ends. According to this conception philosophy is commonly regarded as different in essential nature from science. It pursues different methods and in reality occupies a different dimension of thought. The two do not mix. Each one has its clearly defined area of operation. Each performs certain necessary functions within its own area but is incapable of performing the functions which belong to the other method. This conception of philosophy as having the distinct problem of setting up goals or establishing values is suited only to the absolutist's conception of the nature of philosophy. Philosophy, according to this idea, determines ends or values, not by analyzing human experience, comparing the results of this or that type of behavior in terms of human satisfaction, but rather through some speculative or abstractly logical thinking process. It is interesting to note that this view of the matter seems to be held even by some educational philosophers who professedly adhere to the pragmatic doctrine.

One of the founders of pragmatism, Professor Dewey, is quite clear in repudiating this conception of the function of philosophy in education and of its relation to science. He says in his recent essay, entitled "The Sources of a Science of Education":

> It is sometimes said that philosophy is concerned with determining the ends of education while the science of education determines the means to be used. As one who is a philosopher rather than a scientist I might be inclined to welcome a statement which confers upon philosophy such an honorable position. Without a good deal of interpretation, it is, however, likely to give rise to more false than true conceptions.

Again,

> As far as ends and values are concerned, the empirical material that is necessary to keep philosophy from being fantastic in content and dogmatic in form is supplied by the ends and values which are produced in educational processes as these are actually executed. What a philosophy of education can contribute is range, freedom and constructive or creative invention. The worker in any field gets preoccupied with more immediate urgencies and results. When one begins to extend the range, the scope, of thought, to consider obscure collateral consequences that show themselves in the more extensive time-span, or in reference to enduring development, that one begins to philosophize whether the process is given that name or not. What it terms philosophy is only a more systematic and persistent performance of this office.

In another place Professor Dewey protests against the psychologist confining himself to the study of such processes as learning to read without considering the broader effects upon the child's mental development of learning in one way or another. He says:

> It will not do for the psychologist to content himself with saying in effect: "These other things are none of my business; I have shown how the child may most readily and efficiently form the skill. The rest is up to somebody else." It will not do because one skill is acquired, other abilities, preferences and disabilities are also learned, and these fall within the province of the psychological inquirer. (sic)

It is, of course, equally true that a philosopher is not justified in saying to the psychologist, "The study of these minute details are in your province but the consideration of the larger issues are not your business at all." It is only a narrow conception of the meaning and function of psychology or of science in general which confines it to the more minute and technical problems of investigation. There is, in fact, no definite and rigid demarcation between the study of values or ends and the study of means. Professor Dewey dwells on this point emphatically. In fact, it is an essential feature of the pragmatic doctrine that values develop in the course of activity and are not worked out by abstract reflection alone and imposed upon the experience of everyday living.

If values and ends are not drawn down from the thin air, but rather grow out of our experience in meeting the exigencies of practical life and of reflection upon them, and if this reflection constitutes the method of philosophy, it is obvious that philosophy and science deal with the same material. It seems further evident that the methods are not necessarily diametrically opposed but rather overlap one another to a large degree.

The question now arises as to whether, as science develops its method of analyzing human experience, it may not offer a more refined and more reliable method of deriving values and ends than the purely observational and reflective method which characterizes philosophy. The point of view here suggested is that philosophical reflection serves provisionally as a means of evaluating procedures, but that it must give place to science as rapidly as science can perfect its methods of analysis. The values which are set up by this analysis must justify themselves in experience instead of being justified on the criterion of internal consistency, logical coherence or the appeal to individual preferences. The values must be regarded as hypothetical rather than as ultimate. The variations in values which are found to obtain in the societies of different peoples must be evaluated in terms of their outcomes in the lives of these peoples.

In attempting to evaluate forms of education, or, more broadly, forms of human organization or behavior, science seems justified in accepting a few basic assumptions, if not ultimately, at least provisionally. For example, it seems safe to assume certain conditions of body and mind as desirable and their opposites as undesirable. These are not to be regarded as ultimate ends but only as elements in a general scheme of values. General consensus of opinion would seem fairly to support the acceptance of these items as universally good: life itself, the prolongation of life, zest in life and the desire to live, a generally pleasurable feeling tone, the vigorous and effective performance of the fundamental functions of life, health of body and of mind, the development of those forms of social organization which promote these ends and the progressive enrichment of human experience. Those forms of treatment of the child and those forms of behavior which, in general, promote these and similar ends may in so far forth be regarded as worthy, and those which hinder them, in general, and in the long run, may be regarded as undesirable. These very assumptions themselves should not, of course, be regarded as beyond the pale of analysis or investigation, but the acceptance of some such assumptions will be found, I believe, to underlie our judgments concerning human values. This is true whether we think philosophically or proceed scientifically. The difference in the procedure is that, in the one case, we depend upon casual observation for the data with which to make our analyses and to draw our conclusions, whereas, in the other case, we collect our data systematically.

We have seen that in so far as philosophy deals with experience rather than with speculation, it deals with the same material as science and its methods may even shade into the method of science. The same relation holds with reference to the use of the hypothesis in thinking and in scientific investigation. Philosophers have sometimes regarded it as their function to examine the unrecognized hypotheses or assumptions which underlie the procedure of scientific workers. It is, of course, the privilege of any competent critic to examine the hypotheses which underlie the procedure of scientific workers or of speculative thinkers. Just why one group should adopt the specialized function of examiner of hypotheses, however, is not quite so clear. It would seem to be the duty of any scientific worker who undertakes to interpret the data with which he deals to examine the assumptions which underlie his own conclusions and not to rely upon someone else to perform this function for him. The person who makes scientific investigation should assume the responsibility for interpreting his data and his findings and for thinking through his arguments clearly from the foundation to the conclusion. Experimenting does not absolve the scientist from the duty of thinking and of observing the canons of correct thought. He may receive thankfully any suggestions from any qualified person whatever regarding errors in his procedure or in his interpretation, but he can not be satisfied with the division of labor which absolves him from thinking about his own findings as profoundly as he can.

A slightly different function which is sometimes regarded as a special problem of philosophy is the setting up of hypotheses. It has been pointed out that fruitful hypotheses are sometimes suggested by speculative thinkers before they have been thought of, much less tested, by scientists. The theory of evolution is cited as an example; and the laws of falling bodies, which were investigated by Galileo, constitute another example. These, however, are rather ancient instances and they occurred at a time when philosophy and science had not become distinguished from each other. The same person was likely to be both a philosopher and a scientific worker, as illustrated in the person of Aristotle. Science was in the early stages of its development when the known facts were not very numerous and the technique of scientific investigation had not been elaborated. It should be pointed out further that philosophical hypotheses, such as that of evolution, remain com-

paratively unfruitful until they are attacked by the elaborate and detailed methods of science. Furthermore, and this is perhaps a more serious matter, the speculative thinker who derives an hypothesis but is not equipped with the technique or has not acquired the habit of scientific investigation, is very likely to treat his hypothesis as a theory or even as an established principle and to neglect altogether the necessity for verification. If one does not check up on one's guesses or hypotheses by painstaking investigation it is fatally easy to pass by imperceptible stages from a guess to an hypothesis, from a hypothesis to a theory, and from a theory to an established principle. It is to be feared that much of our so-called philosophy of education consists of little more than principles derived in this fashion.

If hypotheses are to be fruitful they should be kept in as close relation as possible to observed or objectively described situations. They should grow out of actual problems which are presented concretely and in detail. They should be tested and verified or rejected by further observation, supplemented, if possible, by statistical and experimental investigations. This is the scientific method. No scientific investigation of any serious consequence can be carried on without the employment of hypotheses. They are part of the indespensable stock and trade of the scientific worker.

This fact is not only a commonplace of scientific methods; it is in strict accord with the principles of pragmatic philosophy. Pragmatic philosophy, in fact, is simply the philosophical justification of the scientific method. It means that, so far as the practical control of the affairs of living is concerned, such control must be worked out and exercised by experimental adjustment to the practical conditions of life itself. It can not be turned over to the absentee control of pure reason or speculative thought, elaborated in seclusion from the conditions which life presents and the problems which are involved in them. This means the development of principles through experimental procedure; and experimental procedure is the method of science.

It is obvious that science has been used in this discussion in the broad sense of the term. The critics of science as the predominant method of control of the procedures of education frequently restrict science to the more rigidly technical forms of scientific research, and sometimes restrict their consideration to the past achievements of science in education without regard to the possibilities of its future development. The exponent of science in education can well afford to be modest concerning its past achievements and even concerning the techniques which have been developed up to the present time. The contention is not that science has yet established a basis for all the procedures of education or even for a considerable part of them. For the length of time it has been in operation, the scientific method has given a fair account of itself. The main contention of this paper is that it is the scientific method rather than the philosophical method which offers the possibility of continuous and sure advancement toward a more and more adequate solution of the problems of education. When science has once conquered a bit of territory, that territory is acquired in permanent possession. Mistaken theories may be adopted which are later shown to be unfounded, but in general science moves steadily onward.

Genuine philosophical speculation has its own canons of criticism. It may, within its own sphere, be as rigid and as careful as is scientific investigation. Those who pursue philosophical speculation, however, recognize the limitations of its sphere. They do not undertake to make it do a work for which it is not fitted, namely, to determine the issues of practical living. One who is not interested in the pursuit of speculative philosophy may adopt pragmatism, which eschews speculative problems and busies itself with the problems of practical living. Such a person must realize, if he thinks his way to the end, that the ultimate goal of such a procedure is a wholehearted adoption of the scientific method. He can not stop at any half-way point. If he does, he abandons the canons of one rigid discipline without taking over the canons of the other discipline which properly takes its place.

The issue is one of practical importance. The contrast between what often passes for the philosophy of education and the pursuit of the science of education is too often the contrast between a method of thought in which the thinker is unwilling to take the laborious and painful course of checking up his opinion step by step and the method in which the attempt is made to subject one's thinking to careful verification. The habit of building up a structure of opinion without constant and painstaking weighing of evidence and without constant reference to particular facts for the purpose of verifying and correcting these opinions is all too easy to acquire and all too difficult to outgrow. No one would probably lay claim to having entirely outgrown this insidious habit. It is within the province of every one, however, to declare his commitment to a method which requires that opinion shall grow out of detailed examination of all the facts pertinent to the problem, and as complete a testing of his opinion as the technique at his command will

allow. In dealing with those problems to which the scientific method of investigation has not yet been successfully applied we shall all need to philosophize, that is, to use our best judgment in the light of the facts which are available to us. This philosophizing, however, can best be done as an integral part of the consideration of each particular educational problem. There is no justification for setting apart those aspects of educational problems on which the evidence is not yet complete and treating them in a separate discipline. Furthermore, we may look forward to the gradual reduction in the scope of problems which must be attacked by this method, and we should use our best efforts to enlarge the scope of those problems which may be successfully attacked by the scientific method.

OBITUARY

WALDEMAR M. W. HAFFKINE

THE sudden death on October 27 in Lausanne at the age of seventy of Dr. Waldemar M. W. Haffkine, bacteriologist and immunologist, deprives the world of one of its most illustrious scientists. Inasmuch as Haffkine's work in combating and, to a large extent, conquering epidemic scourges was of universal benefit and inasmuch as his career as an investigator was truly international—being carried on under the auspices of various nations and races—it is appropriate to devote a few words of appreciation to his memory in SCIENCE.

Dr. Haffkine was born in Odessa, in southern Russia, on March 15, 1860. At the age of twelve he entered the gymnasium at Berdiansk and from the very first he exhibited a bent of mind in the direction of science and experimental investigation. In 1879 he entered the University of Odessa as a student in the faculty of science and in 1883 he took his degree of doctor of science. He remained at Odessa for five years, working in a laboratory fitted out for his special use in connection with the zoological museum of the university, and devoted himself to the study of difficult problems relative to the fundamental phenomena of organic life. At the beginning of 1888 he was appointed assistant to Dr. Schiff, professor of physiology in the University of Geneva, a position which he held for a year and a half. About the middle of 1889 he found his true sphere of work on being called by Pasteur to Paris. He became one of Pasteur's most eminent pupils.

In Paris he began the study of typhoid fever and cholera and soon discovered the principle and method of inoculation with attenuated virus against the latter. As early as 1891 his work along that line had progressed so far that when Prince Damrouy, brother of the King of Siam, called on Pasteur and asked him to supply a remedy for cholera, the illustrious scientist referred him to Haffkine for aid. A few months later Haffkine's first paper on the subject was given to the world.

The two of Haffkine's most important contributions to the science of medicine are his investigations of the devastating scourges, cholera and the plague. It is perhaps in connection with cholera that Haffkine is better known. In 1893 he went to India to conduct investigations on cholera for the Indian Government, making Calcutta his headquarters and extending his operations over the whole of Bengal and into the Punjab, the Northwest Province and Assam. In 1896 he was deputed by the Indian Government to inquire into the bacteriology of the plague and to devise means of combating it. Here again he discovered an effective method of inoculation and succeeded in reducing the mortality from 80 to 90 per cent. In recognition of his services to the British Government, he was created Companion of the Order of the Indian Empire. The Haffkine method of inoculation for both cholera and plague has been generally adopted throughout the Orient, and the government research laboratory which he founded issues many thousands of doses of vaccine for the effective inoculation and treatment of epidemics in various tropical countries.

Haffkine's contributions to biological research and medicine include various monographs and official reports not only on the cholera and the plague but also on a variety of other subjects, heredity, biology of monocellular organisms, general problems of bacteriology, etc. Although retired from active work for the past few years, he continued to interest himself in various scientific investigations, which he carried on particularly at Lausanne.

Haffkine's work on cholera and the plague places him in the class of those pioneers in medical research who have immortalized their names through the alleviation of suffering and reduction of mortality caused by such wide-spread infections as malaria, diphtheria, yellow fever and trypanosomiasis. As a scientist, Haffkine was meticulously careful and accurate in his work as well as ingenious in his methods. As a man, his character might be summed up in the following words, a quotation from a letter received by the writer from Dr. M. Ascher, Bex, Switzerland, who attended the funeral: "Great was his scientific work in that he literally saved millions of lives but equally great was the personal character of the man and, most particularly, his modesty and humility. He never asked for help from any man but he was always ready to help