will be just as loud all the year as it was this summer. But, to hear it, we must transmute the peace and beauty of Nature into purpose, industry, hope and poise. The summer's pictures should never be dimmed by winter's labor. Let us, this year, be as firm as the mountain, peaceful as the lake, punctual as the tide, free as the bird, industrious as the bee, poised as the cloud and as beautiful as the flower, recalling ever the harmony and peace of all Nature.

SCHOOL SCIENCE ventures to present to its readers the following obligations, which we, as teachers, may meet if we accept them in unshaken confidence in our accumulated strength:

To remember that some good is in all pupils, and to crave that spiritual insight which shall detect the best; to lead all pupils on to higher attainments; to be patient, composed, forbearing; to be confident in the belief that the truth will ultimately triumph; to scorn error, deceit and all forms of falsehood; to forego sarcasm and injustice; to honor the body; to cherish daily communion with the soul; never to voice the thought of drudgery, routine or performance of duties rightfully another's; to sweeten others' labors with kind words and sincere greetings, and to gladden our own with a silent joy in the dignity of honest labor; to accept our remuneration, large or small, without envy, complaint, discouragement or covetousness, never forgetting that a teacher is a leader into the higher life—not a wage-earner merely; to work each day in unshaken assurance that fullness of peace, power and plenty comes to those who "see the heavenly vision undimmed."

L. C. N..

A PLEA FOR THE STUDY OF EDUCATIONAL PHILOSOPHY ON THE PART OF TEACHERS OF SCIENCE.*

BY N. A. HARVEY.

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The results of the teaching of science in high schools have not been altogether satisfactory. There is a feeling, more or less prevalent, that the claims of science have been fully justified.

*Part of the President's Address before the Department of Science Instruction of the National Educational Association read at the Detroit meeting, July 11, 1901.

This finds expression in occasional articles in educational journals, in the recent great gain in the history and language courses over science in high schools and in the refusal of colleges and universities generally to demand science as a requirement for admission.

I cannot but feel that there is some ground for this coolness toward scientific subjects. My own experience would lead me to say that there may be some reason for the position that universities assume. I have recently had occasion to teach two classes a day in physics for three successive years. One was a class of high-school graduates, all of whom had studied physics. The two classes did identical work in the laboratory. For three successive years the tabulated records of the accuracy of data obtained in the laboratory showed that the class which had never before studied physics exceeded the accuracy of the high-school graduates in the proportion of about seven to three. It was a case peculiarly favorable for comparison, and I feel sure that the comparison is indicative of an actual condition in those classes.

The only explanation that I can suggest is that the teaching of the high-school graduates had been conducted under the influence of improper ideals; that the teachers were physicists rather than teachers; that, in other words, they needed to study educational philosophy and to get a rational knowledge of the content of the subject.

If there has been one advance in educational truth better demonstrated than another, it is that, in schools for general education, the knowledge of the facts acquired is not the chief value to be derived from a particular study. There is something more important than that, even in science. Just as the benefit derived from the study of algebra is not to be looked for in the answers to the problems that the student so laboriously solves, and the value of the study of Latin comes not from the knowledge of the historical facts that the pupil learns while reading the Latin language, so the value of the study of science does not depend upon the knowledge that the pupil acquires, but upon the power the student acquires while gaining that knowledge. In physics one set of exercises may be substituted for another without any disadvantage. It makes no difference whether one

class of animals is studied in zoölogy or another, provided other things are equal, and one set of exercises in chemistry may be a full equivalent for another series, yet it would be wrong to give both. In fact, there is recognized a fair degree of equivalency among scientific subjects—something in which they agree among themselves and differ from other subjects in their power to influence the mental habits of students.

In our work in zoölogy we study the structure and life of animals, but if my classes fail to see and to recognize the processes by which a general concept of a group is formed, if they fail to discriminate and compare, if they do not get into the habit of analyzing a specimen before them and of examining it part by part, if they do not learn what is involved in a logical definition, and, more than this, if they do not carry this habit of mind into every other subject in school, I feel that my work has been a failure, no matter how many or what animals they have studied, or how neat their notebooks, or how artistic their drawing.

In the determination of the laws of falling bodies if my classes fail to perceive the continual activity of a constant force by means of the effects, if they do not recognize the uniformity in the apparent diversity, if they do not recognize that here is a law, and how to perceive that law, if all that my students get out of the exercise is a knowledge that $s = \frac{1}{2}gt^2$, or, even worse, if they only learn that, in the laboratory, they can get the result that the text book says they can get, that the book has told the truth, and they have verified the statement, then I am not only a failure as a teacher, but I am a sham and a fraud, and my laboratory is part of a juggler's outfit, the principal purpose of which is to dazzle the pupil and the public. (This is a confession and not an accusation. In classical language, I have been there.)

If, in the determination of copper in copper sulphate, I fail to make my pupils see that the atoms of copper in the final compound which is weighed are the identical atoms with which we began; if the pupil is unable at any stage of the proceeding to point out where the atoms of copper are, then my work is a failure and the educational value of chemistry is either accidental or negative.

The results obtained from the pursuit of scientific subjects

under the influence of such a conception are likely to be very different from what they would be if it were believed that the knowledge of a few animal forms, or a few experiments in physics, were the purpose of scientific study. Of course, it is understood that a professional chemist or an electrician, or an investigator in biology, must know the facts of the particular branch of science that engages his efforts, and must set to work directly and explicitly for the purpose of learning those facts. But that is a phase of work that does not apply to high-school science.

I do not decry the learning of facts, nor would I set up for the pupil this more important but less tangible aim. By a pupil's knowledge of facts the teacher may test, in a measure, the clearness of comprehension, the awakening of power that the pupil obtains. But the teacher must look beyond the mere facts of the subject to the true content that furnishes the reason for its introduction into the curriculum.

The day has gone by when a knowledge of subject matter is considered sufficient preparation for teaching. How much knowledge of mathematics, higher and lower, is necessary to make a person a good teacher of fourth-grade arithmetic? How much knowledge of literature and language would guarantee success in teaching third-grade reading? How many university graduates would undertake a position in the grades of a city school with assurance of success? It is only a tempting of Providence that permits persons too poorly prepared to do grade work to teach in a high school. The application of pedagogical principles is as necessary to high-school work as it is in other grades, and university methods and models are not always capable of universal application.

The teaching of science is still in an inchoate and formative condition. There is no general agreement among teachers of any science, nor between different schools, concerning what shall be taught. Perhaps physics is the science which in high schools is best taught and most clearly defined. But physics in one school means a very different thing from what it does in another school.

The past few years have witnessed many attempts to formulate a course of study in science that shall constitute a point of departure for the teaching in high schools; something that high

schools can teach and that colleges can reasonably expect; something that shall be of value to all students who do not expect to go to college, and yet something that shall be a fair equivalent for the preparatory studies that are now required for entrance into college. This section of the N. E. A. four years ago appointed a committee for the especial purpose of formulating such a course. That committee, after much work, failed to agree, and, so far as accomplishing what it undertook to do, it is as if it had not been. No such course has yet been formulated, and I believe that no such formulated course ever will be generally adopted until it has its basis in the activities of the pupil rather than in the facts of science. A successful and meritorious course in science can never be made by addition nor subtraction nor substitution. No series of exercises can ever be presumed to give constant results. It certainly is not possible at the present time—and may never be possible—to state a course of science in terms of mental activity. But, until that is done, all of our courses in science must be tentative and unpedagogical. Until someone makes a study of the psychology of laboratory science, or shows just the phases of human activity that are most economically cultivated by each scientific subject, our teaching must continue to be more or less empirical and unscientific.

The recent recovery of classical subjects from threatened displacement has followed the recognition that the language of a people is the key to the thoughts of a people, and not merely a quantity of information, valuable or useless as the individual judgment considers it. The revival of history has come about from recognition of the fact that history is an expression of the life of a people, and not merely a catalogue of miscellaneous events. A similar change must occur in the teaching of science. The purpose and reason for science instruction must be sought for in the mind of the pupil, and not in the facts of the subject. For this aspect of the case I plead with all the earnestness of a decided conviction.

The greatest contribution of science to pedagogy has been the "scientific method." The "scientific method" is not a method of teaching, but it is a method of thought. It is a method capable of universal application. This universal method in all of its ramifications, should constitute the basis for all our courses of study in

science, and should determine the method and data of our teaching. I plead for a study of this universal method of thought, and for its exemplification in the things we teach. Then will there be no question concerning what shall be the course of study in science, no hesitation on the part of colleges to accept it as a college-entrance requirement, and no doubt concerning the value of science teaching.

THE AIMS AND PURPOSES OF MODERN WORK IN BIOLOGY.

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The modern epoch in the history of biology dates from the epoch-making work of Darwin and the publication, in 1859, of *The Origin of Species*. For forty years Darwinism has been the chief dominating influence among biologists, stimulating not only fierce and prolonged controversy, but also patient and equally prolonged study and research. For the first decade after the promulgation of the evolution doctrine, the scientific world was arrayed in two hostile camps; Darwin and his followers fought, side by side, through the long campaign, until they compelled the unconditional surrender of every important stronghold of science. And then, the victory won, these comrades in arms began to emphasize their own individual creeds, and to wage controversies among themselves, which have developed for the last quarter century, until, today, the term "Evolution" stands for a heterogeneous mass of doctrine, in which we may discern at least three distinct schools, and a bewildering number of different shades of opinion. Thus, at the end of forty years, we are able to trace considerable progress in the evolution of an evolution theory. The *fact* of organic evolution is, practically, unquestioned. The lively controversies of today are concerned with the *methods* of evolution and imply a deeper and broader knowledge of the problems of life than was possible before Darwin's day.

While we recognize the important directive influence of Darwinism upon his own time and ours, we must not forget the bril-