ence? "When science, provided she be mindful of her honor, and make no sacrifices of her love of truth, serves as the handmaiden of even the humblest of arts, her dignity gains in lustre, and her familiarity breeds respect."

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THE SCHOOLMASTER AND THE TEACHER[1]

IT is very much to be feared that what I have here to say will appear so trite as to be little better than thrashing over of old straw. I am quite sure that much of it has been said (and perhaps better said) many times before. But no student of the problem of science teaching can observe the changes that are taking place in the system of scientific education, and particularly in the character of the results of the teaching of chemistry in our colleges and universities, without feeling that we still have much to learn about how to teach successfully. We cannot regard the subject as being closed. No one has yet discovered the grand secret in its entirety and no teacher of any branch of chemistry, who is both intelligent and honest, can be wholly satisfied with what he observes is going on in the minds of his students, as a result of his contact with them. This is my only excuse for reviving this ancient subject and for adding another bit to the already formidable accumulation of treatises directed toward the solution of such important questions as these.

I do not propose to offer to this section the affront of trying to tell you how to teach chemistry. Many of you have had far more experience in this field than I. Indeed, I frankly confess that I am not an authority on the art of teaching. If I were I should simply write out the recipe, and have it mimeographed and distributed; this you would then properly consign to the waste basket, for each one of you would know of a much better way than the one I would give you. There is no magic word or phrase that is the "open sesame" to the door of success in teaching. Each of us possesses, in some degree, the ability to instruct. But the part that one does well another does poorly. What both fail to attain another will accomplish, and so on. Were it not for this we should not be here to-day, gathered for a mutual exchange of ideas.

For this reason I shall presume upon your time and good nature long enough to say a few things about the general question and about some of the results of my own observations. These may be taken for just what you consider they are worth—no more (of course) and no less (I hope).

Much has been said and written about the necessary qualifications of a teacher. And, after all is said and done, we might finish by saying that the successful teacher of chemistry is one who can teach chemistry. Teaching is not coaxing or coddling, cramming or browbeating. Neither is it the administration of sugar-coated knowledge pills, to those who would cultivate the luxury of sleeping sickness. Our job is so to conduct our classes that our students shall be glad to be in them and that they shall leave them with regret, but carrying with them not only the fullest possible knowledge of the subject but also a deep and abiding respect and love for their chosen science and a boundless enthusiasm for its possibilities. Not an easy job, this, by any means,—as we all know. On the contrary it is one that requires large experience and training and large understanding of human possibilities, human ambitions and human habits of thought.

With this introduction and apology may I begin at what may seem to be the wrong end of the business by saying that the very first requisite for the teaching of chemistry is correct personality on the part of the teacher. This is not a prime necessity for successful work, for example, in chemical research or chemical industry. The researcher *must* have thorough training in fundamentals, thorough knowledge of chemical literature and a logical mind, capable of clear and systematic organization and prosecution of his work and, having these, he may be eminently successful even though his personality may be such as to cause him to be thoroughly disliked by all of his associates. Pray do not understand that I charge the industrial research chemists with such a

[1] Paper read at the Pittsburgh meeting of the American Chemical Society, September, 1922.

lack of human characteristics. On the contrary, I know and admire many of these gentlemen who I wish to heaven were now in the teaching profession, because I know that their influence over our young students would be of enormous benefit to the progress of the science. I simply state that the research chemist *may* do without personality, though the teacher cannot.

Much has been said, one way or another, about the correct method for developing the subject of chemistry in the class room and student laboratory and much more will be said. We want our students to understand that chemistry didn't simply happen but that as we have the science to-day it is the product of hard and careful work and of an infinite expenditure of human brain power, on the part of those who, in the past and present, have been able to search out and to reason, and who have known the virtues of cold, invincible scientific logic. How to impress this most satisfactorily is not an easy question to answer. I do not know just how to do it. I have heard discussed with much feeling the burning issue as to whether or not the beginner should be allowed to see (and use) a chemical formula before he has been taught how and why the formula was evolved. I do not know which is the right side of this question, although I know a great many other people who do know—both ways. What I know is that we may argue this question until doomsday but by neither the one system nor the other can the teacher ever inspire the student with either respect or love for chemical science except as this may be founded upon the prerequisite of respect and love for the teacher himself and that no one need expect ever to attain success in the work of science unless he has respect and love for that science. The student must believe what the professor is telling him and this belief must be so deep-seated that he is inspired thereby with enthusiasm to know more of that which forms the chosen life work of his teacher. In the very nature of things, such a working belief must have its origin, in the largest degree, in an interest springing from the personality of the teacher himself.

It may be that this is only "kindergarten stuff"—or it may not be. I am not a psychologist, though an observer of psychology as are we all. As I recall my own teachers in the grades, high school, college and university, I am more than ever convinced that it was only in the classes where my teacher was a respected and admired leader that I learned much that was of any lasting benefit to me. It may be that this was my fault. It might well be argued that it is always the business of the student to exert himself to the point of learning that for which he has entered the class, without regard to his personal feeling toward the instructor. However we are not so much concerned with an effort to place the blame for failures in teaching as we are to discover the failures themselves and to avoid them wherever possible.

The business of the teacher of chemistry is not simply that of handing over to the student, through an approved and standardized system of pedagogy, a set of facts and elaborately developed theories, with the invitation to take it or leave it. How often have we seen this tried —how often have we even had it tried upon us! "Here is chemistry," says the instructor, in effect, to us. "I am paid for giving you the opportunity to get it. If you want it, take it, if not, get out." The student can find no fault with this. The procedure is obviously just to him and the problem is thus placed squarely before him for his own solution. And yet is it not true that the result of such teaching is generally little better than a dull sort of forced interest,—at best a determination on the part of the student to "get by" in the course or to acquire a smattering of the subject, sufficient to do something in the way of earning a livelihood after graduation?

It may be that a teacher after this fashion earns his salary, in a technical sense, for he has gone through the motions of teaching a given number of classes of the correct number of students, properly and each day according to schedule. But I think that we all concede that the real work of the teacher of chemistry is something quite different from this. To him is given one of the most important trusts of science: that of helping to equip his students with that which should enable them to do useful and efficient work in a field that calls for the highest kind of enthusiasm and energy. Dullness and passive acceptance of a teacher's

dictum has never and can never equip a young man or woman for work of this character.

The teacher of chemistry must himself be an original investigator. It is not essential that he shall have attained brilliant success in this field. It is only the exceptional few who are capable of that and most of us must be content with adding in a more humble fashion to the sum of scientific knowledge. But a professor of chemistry must do more than "profess." He is either going to leave with his students the impression that chemistry is now practically a finished story, with little more to be written, or else he must show them that it is a living science, the delving into which is a fascinating and necessary part of the activities of the devotee of chemistry. The student is not long in discovering that the first impression is erroneous, upon which he loses all confidence in his instructor that he might have felt. And the teacher can not consistently teach the second attitude unless he is himself doing something toward uncovering the hidden things of his science. Precept and practice must go together in this case or else the precept will become merely a dead formula.

The student of chemistry must be taught that chemistry, as all science, is the truth of nature and that as such it is to be respected. We may, and do, change our minds occasionally about whether a particular interpretation is the truth but we never doubt that science itself is truth and that before it all sham and pretense and hypocrisy must give way. This is the reflection that makes us respect science above all things and if we fail to bring the student to a full realization of it we have failed in our mission as teachers. Nothing else can supply the want of it and it is because of this want, in greater or less degree, that our colleges turn out too many men whose highest ideals of scientific work contemplate juggling with scientific knowledge and trifling with scientific truth in such a way as to win out in conflicts with other folk of similar character, whose wits are pitted against them. This (to use a bit of common slang) is why we have our shyster chemists as well as our shyster lawyers. The only way by which a teacher can instill a proper respect for chemistry into the life of the student is by showing in all of their mutual contact that he himself feels it intensely.

Carlyle tells us, in his vigorous and striking way, that the upheaval involved in the French revolution swept away all sham,—that imposture was burnt up by it. Which was, no doubt, true in the sense in which he wrote. But how long will it be before we shall have an end of sham and imposture in chemistry, before our fakers of science shall have been cast into the outer darkness of contempt? Too long, we are led to fear, when we contemplate the attitude of a certain fraction of our yearly crop of graduates, whose outlook upon life and whose sense of responsibility toward the cause of science has suffered through too much contact with schoolmasters of science and too little companionship of teachers.

One of the most difficult of tasks imposed upon the teacher of chemistry and other science is that of creating in the minds of his students the proper attitude toward questions of religious belief as they are related to scientific study. I have heard the "conflict" between science and religion discussed *ad nauseam* for so many years that it has become almost a positive discomfort to me to attend church services, especially in a college town where so much attention is given by religious teachers to students of science who are trying to straighten out their mental troubles along these lines. And trying vainly, it seems to me, in most cases, largely because they have not the proper help from the source upon which they have the right to place the most reliance,—that of the teachers of science in the college. What usually happens is that the college teacher goes right ahead with the thing he is paid for doing. That is, he teaches his science and nearly or entirely ignores religious questions because he knows (whether he proclaims it publicly or not) that the study of science is the search for truth by absolutely the only method that can ever discover truth,—that of experimentation and logical reasoning,—but that our religious leaders will not and can not admit this without giving up a great mass of what they mistakenly consider as essential to religion.

The student is thus left entirely to his religious leaders for instruction in matters that

are of great and vital concern to him. The religious leader is too often nearly or entirely untrained in matters of science and in scientific methods of thought and (still more unfortunately) he is frequently unaware of his own limitations in this respect. It, therefore, happens that there come from our pulpits and our Sunday School classrooms great quantities of instruction designed to quiet the "doubts" of students of science, the religious instructor making use of a patter of scientific words and phrases, abused and garbled, with good intentions, but with lack of understanding, so that the student is more or less self-hypnotized into a temporary state of mental quietude concerning these matters.

If affairs were as they should be, our teachers of science would be perfectly correct in confining their efforts to the teaching of their own special phase of science. For true religion is a matter of the soul and it has little or nothing to do with any science, unless it be that of psychology. But *what passes for religion* in the minds of many (if not most) people is of very vital concern to the scientist because it contains a mass of dogma which can not be reconciled with the truths of science as we accept them and which is not susceptible to test by any method. And I maintain that no teacher of chemistry, biology, physics or any other science can consider his duty to his students as fulfilled if he allows them to cultivate one attitude and acquire one set of ideas in the classroom and another, incompatible with the first, in the pew. They will ultimately either come to a point of forsaking their religious beliefs entirely or to that of passive acquiescence in something which they can not, really and truly, believe. The latter is a state of mind all too common to-day and it is not a healthy state for either true science or true religion.

I have not meant simply to inflict a preachment upon you,—many of whom know far better than I of the things of which I have briefly spoken. But it has seemed to me desirable once again to direct our thoughts toward the problems of teaching,—not as they relate to the preparation of the student, the system of teaching or the arrangement of content of courses —important as all of these are,—but as they go back to the teacher himself, for upon him as a man must finally rest the responsibility for failure, as well as the credit for success. The truly successful teacher is the one who constantly studies himself as he watches the effect of his efforts upon the minds of his students and who continually tries to correct his failures and to strengthen his successes, putting himself in the place of the student, always. We have all had our schoolmasters and our teachers. We have but to project ourselves backward through the years to see examples of what we would wish to be, as well as of what we hope never to be.

E. G. MAHIN

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BERNHARD EDUARD FERNOW

DR. BERNHARD EDUARD FERNOW, author, pioneer educator, organizer of the forestry movement, and the first United States Forester, after a long illness died at Toronto on February 6 at the age of 72.

Dr. Fernow was a native of Germany and studied under the famous Heyer and other noted foresters. He first came to this country in 1876 and soon took an active part in the forestry movement of New York State, where he formulated legislation establishing the Forest Reserve in the Adirondacks. From 1885 to 1898 he was editor of the *Proceedings* of the Forestry Association. Sponsored by this Association was the greatest piece of forest legislation so far adopted in our country—the law of 1891 authorizing the President of the United States to establish National Forest Reserves. This act led to the creation of the present National Forests.

In 1886 Dr. Fernow's great work for the nation really began, when he accepted the position of organizer and director of the forestry work of the government for the Department of Agriculture, a position which he occupied until 1898.

During twelve years at Washington Dr. Fernow kept in close touch with the forestry work in the various states and there was little of state forest legislation passed during this time in which his opinion was not consulted. He secured the cooperation of many prominent men of science and the numerous bulletins and