An aim of a science course is to give training in how to do with a background of knowledge which will allow of a selection in the matter of action. An aim of a biological course is to give training in how to use eye, hands, and brain in the control of ourselves and our environment, with a background of knowledge that will allow of a selection of action.

AIM, INCENTIVE AND CONTENT

Aims, as outlined above, furnish little incentive for work. The ultimate object is too big a picture to be "interpreted" by one so close as a student in a laboratory class. The needed perspective can only be acquired after the course has been completed. Minor aims, clearly within the experience of the student, selected with a thought not only to the principal aims but also with the available material in mind, must be presented. These aims must seem to the student clearly important. Experience has shown that a combination of the problem method as illustrated in Hunter's "Problems in Civic Biology" and the project method now being worked out by teachers in the high schools gives the most science and information with the most incentive.

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PHYSICAL METHODS AND MEASUREMENTS, AND THE OBLIGATION OF PHYSICS TO THE OTHER SCIENCES

SEVERAL months ago there appeared in SCIENCE a brief article[1] by the present writer in which he advocates a carefully planned course in physical measurements, supplementing the beginning course in college physics, to suit the needs of students of the chemical, biological and the related sciences. In response to the article, there have been received more than twenty communications from scientific workers in the colleges and in the industries, relative to the subject. They are unanimous in expressing their agreement with the views stated. At the same time they express doubt as to the existence of a college physics department which will offer a course designed especially for the science student outside of physics.

To those who are working in the various experimental sciences, or who are in position to see and judge the work in numerous laboratories, it is evident that the need for better training in physical principles, methods and measurements is an urgent one.[2] To secure evidence of the truth of this contention, one needs only to obtain the views of the heads of industrial laboratories in which the services of many science graduates of our colleges are required. Or let the physicist who is—and, more than anyone else, should be—interested, interview his scientific colleagues to learn how much the lack of familiarity with physics may have proved a handicap in their own work or in that of their graduate students. There is concrete evidence in the report that some of the industries are contemplating or have already taken steps towards establishing training schools for their young technical graduates, to give them the sort of training which the colleges should have provided.

It seems to me that here is clearly an obligation upon the physicist. It is also an opportunity. It is an opportunity in the sense that if he could be instrumental in providing the coming generation of scientific workers with adequate training in physics, greater progress in science might assuredly be looked for. This not because physics is at all more potent than the other sciences in exploring the unknown, but because it is so fundamental. At every turn we encounter a physical phenomenon; every experiment that is planned involves some sort of measuring instrument, some form of control device, some physical method. Physics plays such an obviously important part in the great majority of researches that it leads one to wonder why

1 SCIENCE, N. S., 50, 199, 1919.

2 On this point "Chemical and Metallurgical Engineer" says: ". . . we know from experience that an adequate familiarity with them (physical methods) is far too often lacking among young chemists, and Mr. Klopsteg's proposal would seem to cover an important gap."

this phase in the education of our science students has received so little attention. It leads one also to wonder why so little attention is paid to methods of instruction and to the proper coordination of the college science courses.

I have said that it is the physicist's obligation to see that the science student—in chemistry, in medicine, in biology, in psychology—may secure the fundamentals not only of general physics, but of the physical measurements and methods which will apply to his work. The obligation logically belongs to physics because the courses are courses in applied physics, and because the work of organizing such courses would unquestionably be easier for the physicist than for the non-physical scientist to whom physics is unfamiliar ground. The latter could not be expected to make a good teacher in physical measurements.

There are obstacles to the realization of what has been proposed. Some of them appear formidable, but where the results to be achieved seem so full of possibilities, let us hope that they may not be insurmountable. Some of the obvious difficulties may be mentioned. The method for their elimination is not so obvious.

Because of the rapid development of physical methods within recent years, and their rapidly increasing applications, their importance may not have impressed itself fully upon those in charge of the student's training. Perhaps they have thus come to value the time spent by the student upon courses in his own field as far greater than equal periods in the physical laboratory. Among their own specialties they see so many things which the student must have before he is fit for his degree. But is not this a biased view?

Let us suppose that a student has received a degree in chemistry, but that his work did not include several subjects in chemistry which might have value to him later. He takes a position in a chemical industry. He is surrounded by chemists; has access to an excellent library; his interest in chemistry is foremost among his interests. Under these circumstances his educational equipment will not long remain deficient in the subjects which he did not get in college. On the other hand, suppose—and this is usually the case—that he lacks knowledge of physical methods and experience with physical instruments. His environment and his interests make it exceedingly difficult to acquire this knowledge and experience, because he is now quite upon his own resources.

Conditions are much the same with the graduate in almost any science, continuing in post-graduate work. Although he is in position to request the information he wants, by applying to the physics department, the physicists have so many of their own problems that, unless his request is a very moderate one, he will have indifferent success in securing the needed information.

In both the cases just suggested, much time and effort would be saved, with better results, had a well-planned course been available for the student. The college physics laboratory is the place where such training should be given. Failing in this, the colleges must expect to see the industries adopt the alternative of usurping one of the functions of the college. This raises the question: why is not such a course of training in physics offered by every physics department? The answer is fairly apparent.

A course like the one suggested, in order to measure up to its fullest possibilities, would require painstaking preparation by the instructor having it in charge. It would be necessary for him to have an understanding of the problems. He would need to appreciate most fully that, in this particular case, physics is a means to an end, and that the student is interested in physics solely for what it can do for his own, more interesting science. To secure the necessary understanding of the problems, he might have to spend considerable time in going through the various scientific journals, to see where and how physical methods are used. Thus he would be compelled to sacrifice some of the time which otherwise he might devote to research. But, in giving up some of his research, would he not actually be rendering a greater service to science than he would in following the alternative course? Yet there are probably few physicists, engaged in teaching and research, who have more than a passing interest in the possible applications of physics to the other sciences. Perhaps it is only natural that the motive of early results of their work, in the form of publications, should far outweigh the motive of results greater and more lasting, but somewhat intangible and long deferred.

Under existing conditions there is undoubtedly another source of discouragement to the physics instructor who would otherwise gladly develop such a course. This is the tendency on the part of our educational institutions to make advancement in rank and salary depend almost entirely upon productive scholarship, sometimes measured in terms of volume rather than quality. Excellence in teaching and conscientious work upon a course of the kind here advocated would hardly be considered productive. The instructor, in doing such work, would be making a real sacrifice to the cause of science. Few can afford to make sacrifices of this kind.

Whatever the solution of the difficulties which have been pointed out, it will probably be satisfactory and acceptable to our educational institutions only if it comes as the result of cooperation on a large scale among the various sciences. Although the responsibility for making physics available in the manner suggested seems to me to belong to physics, the initiative in demanding of physics the kind of training that is wanted belongs to the other sciences. It is their duty to outline to physics what they need, and after the courses have been made available, to maintain an active interest in rather than a passive attitude towards them. And the common motive must be the vision of the significant but, perhaps, little appreciated contributions, through such efforts, to the advancement of science. To find the answer to the problems which are brought up by this aspect of the problem of properly training our science students seems a task worthy of a body like the American Association for the Advancement of Science. The accomplishment of such a task would give a new and fuller meaning to the name of this great organization.

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SCIENTIFIC EVENTS

THE OHIO COLLEGE AND EXPERIMENT STATION

In 1917 the College of Agriculture of the Ohio State University and the Ohio Agricultural Experiment Station entered upon a closer cooperation in their respective fields of work by the appointment of C. G. Williams, chief in agronomy at the station as non-resident professor of farm crops at the college; of Professor J. B. Park and Firman E. Bear, of the college as honorary associates, respectively, in agronomy and soils at the station, and of G. W. Conrey, instructor at the college as assistant in soils at the station. In 1918 Professor Herbert Osborn, of the college, was appointed honorary associate entomologist of the experiment station, and H. A. Gossard, chief in entomology at the station, was appointed non-resident professor of entomology at the college. In March, 1920, C. C. Hayden, chief in dairying at the station was appointed non-resident assistant professor at the college, and Professor Oscar Erf, of the college, was appointed honorary professor in dairying at the station.

In the actual working out of this cooperation the specialists at the experiment station's work by counsel, by lectures at the field meetings held by the station, and by conducting special lines of research which are reported in station bulletins.

The station's field experiments are widely scattered over the state, in order to bring under observation the various soil types and different industries, and these experiments are visited by the higher classes in agriculture at the college.

THE LOUISIANA ENTOMOLOGICAL SOCIETY

At New Orleans a meeting was held on March 5 to discuss the organization of an entomological society or club. The meeting