

WHAT SPECIALIZATION HAS DONE FOR
PHYSICS TEACHING¹

IN his presidential address before the British Association last summer Sir J. J. Thomson, speaking of overspecialization at Cambridge University, said:

Premature specialization injures the student by depriving him of adequate literary culture. . . . It retards the progress of science by tending to isolate one science from another. The boundaries between the sciences are arbitrary, and tend to disappear as science progresses. The principles of one science often find most striking and suggestive illustrations in the phenomena of another.

It is time to inquire whether early specialization among undergraduates in American colleges is unfitting them both for research and for teaching. The theory still prevails in college that it is good to know more than one thing, otherwise there would be no minors, but minors, according to our closely differentiated scheme, are little else than divisions of the major subject. The result appears to be that we are producing graduates whose outlook is too limited to enable them to carry on a piece of original research. They become research assistants with little prospect of ever being very successful at independent work.

L. H. Baekeland in *SCIENCE*, Vol. 25, p. 845, says:

I challenge you to name any truly great man who was merely a specialist. . . . One-sided pursuits are apt to make us very narrow-minded. . . . Overspecialized science is apt to degenerate into a mere hobby where all conception of true proportions and harmony are lost.

The evil of early specialization is particularly apparent when we consider the cause of education—especially that within the college walls. Not only has the regime signally failed to qualify young men for teaching, but there has grown up along with it a distaste for and even a disrespect

for teaching. There are about 150,000 undergraduate students who annually contract with the colleges of the land for instruction, but no one seems to want to teach them. The colleges announce a full staff of instructors—the title still remains—but it is difficult to find a college instructor, educated within the last ten or fifteen years, who makes it his chief interest to teach or who likes to acknowledge that it is his chief business. When asked what he is doing he tries to think of some little piece of research, however insignificant, and he shows impatience and evident embarrassment if obliged to say that he is engaged chiefly in teaching.

President Hadley of Yale, speaking at Johns Hopkins University, February 22, 1909, on "The Danger of Overspecialization," said:

It is not enough to discover truth, we must make it known among the citizens of this self-governing commonwealth. The college is ceasing to have the influence which it ought to have upon the world.

From the *New York Times*, December 20, 1909:

President Lowell, of Harvard, has expressed himself as heartily in favor of bringing the college course nearer to the practical concerns of the community. "A university," he says, "to be of any great value, must grow out of the community in which it lives and must be in absolute touch with the community, doing all the good it can and doing what the community needs. Any institution which is not in absolutely close touch with the community about it is doomed to wither and die."

New York state, which is typical, has about 800 high schools and probably there are not a dozen teachers outside of New York City who are employed in these high schools to teach physics alone. Still, when a young man goes to college with the intention of fitting himself to teach in one of those high schools he is compelled to

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choose a major subject, and if it be physics, for example, his adviser will steer him through a course so highly specialized in physics and so devoid of other things that he is quite unfit to teach anything, and especially a general beginners' course. Among the courses in physics which he takes none will have reference to the experiences of life, but each will be a distinct attempt to prepare for the next technical course beyond. Even if his duty was to teach physics alone he would not know enough about chemistry and other allied sciences to teach physics properly. But what does the college course do for the 750 high schools of New York state in which one person has to teach all the sciences? Or what does it do for the 570 high schools which have only three teachers, or less, apiece, and in which some one has to teach more than all the sciences? No one, however, can visit many of these schools without reaching the conclusion that some of them have excellent physics teaching. In some cases the credit for this is due to the state normal schools, and in some schools the physics teaching appears to be good because they are not trying to fit for college.

One can not read the papers of to-day without feeling that the community is on the point of making great changes in its educational institutions. It appears to want undergraduate students to take general courses in several sciences. It wants these courses to be far more general than any courses now are. It will doubtless insist that these courses shall be given by men who can teach, and who are willing to devote their best efforts to it. A generation or so ago the greatest men in all the colleges were great teachers. With the establishment of universities and the encouragement of research came the decadence of teaching. It is to be hoped that

both research and teaching will be fostered in the future. If, however, things go on as at present it seems probable that the revival of teaching will be brought about by separating the research function from that of teaching.

Our present scheme of science teaching was founded upon educational theories which are not now entertained. We thought that by drill we could develop certain faculties which would functionize in other fields when called upon to do so. Whatever faculties the college teacher thought his pupils ought to have, these he made it the duty of the high-school teacher to produce. We thought high-school pupils might be trained in observation, in accuracy, etc. We thought they might be equipped with a catalogue of fundamental principles and laws, the use of which might appear when they got to college. We thought it possible to teach one single science *thoroughly*, and we said much about teaching pupils to be scientific by concentration upon one thing and we spoke slightly of the general courses. It now seems probable that a man trained to conservatism in one field is no less likely to be a wild-cat in some other field. It has been pointed out that in matters of education, and particularly in the matter of prescribing work for the high schools, the college physicists have been strangely unscientific; dealing with snap judgments when reliable data were not at hand; prescribing out of ignorance where a council of doctors would have been baffled. Who knows that the high school pupil has reached the time of life when he can be trained in exact science without doing him violence? The community wants its young people informed about the interpretations which may be put upon the phenomena and experiences of daily life. The attempt to make pupils scientific before their time

may prevent their ever becoming scientific. Intolerance of those who have the gift of imagination may lead one to try to suppress a Davy or a Maxwell.

Public dissatisfaction with the teaching of to-day is expressed by many. Let me quote a few.

L. B. Avery, of California:

Physics is the most fundamental in its conceptions and the most practical in its applications of all the sciences. The proposition to leave any portion of those who take a complete high school course with no knowledge of it is in itself a complete acknowledgment of the educational inadequacy of the present methods.

L. H. Bailey, of Cornell:

Distinguish between the teaching function and the research function. We are teachers. It is our business to open the minds of the young to the facts of science. . . . Nature study is a new mode of teaching, not a new subject. It is just as applicable to the college as to the common school. . . . We should be interested more in the student than in the science.

T. M. Balliet, of New York University, in *School Review*, Vol. 16, p. 217, has an exceedingly good article, but too long to quote, on "The [evil] Influence of Present Methods of Graduate Instruction on the Teaching in Secondary Schools."

W. S. Franklin, of Lehigh:

My experience is, most emphatically, that a student may measure a thing and know nothing at all about it and I believe that the present high school courses in elementary physics in which quantitative laboratory work is so strongly emphasized, are altogether bad. . . . I believe that physical sciences should be taught in the secondary schools with reference primarily to their practical applications. . . . I can not endure a so-called knowledge of elementary science which does not relate to some actual physical condition or thing. . . . Either you must create an actual world of the unusual phenomena of nature by purchasing an elaborate and expensive equipment of scientific apparatus, or you must make use of the boy's everyday world of actual conditions and things.

David Starr Jordan, of Leland Stanford University:

For colleges to specify certain classes of subjects regardless of the real interest of the secondary schools and their pupils is a species of impertinence which only tradition justifies. . . . In general, the high-school graduate who has a training worth while in the conduct of life is also well-fitted to enter college for further training. The average American boy quits the high school in disgust because he can not interpret its work in terms of life.

S. V. Kellerman:

Only by teaching honestly what the world needs, and can use, may the schools accomplish their lofty aims.

No one has stated the dissatisfaction with present practises more justly than Principal W. D. Lewis in the *Outlook*, December 11, 1909, in an article entitled "College Domination of High Schools," from which I make an extract or two.

The high school is failing in its mission because its methods and scope of instruction are determined by college entrance examinations made by specialists whose point of view is not the welfare of the student, but the (supposed) requirements for advanced study of certain subjects. . . . Our present college-dictated high-school course is ill adapted to the real needs of the people in that it places the emphasis on the wrong subjects, and practically eliminates those that would be of the greatest practical value in the lives of the vast majority of pupils whose only opportunity for higher education is in the public high school. No less destructive of the welfare of the masses is the limitation in method of treatment of the subjects taught. . . . College teachers have written the courses, trained the teachers, set the examinations and execrated the results.

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FOUR INSTRUMENTS OF CONFUSION IN TEACHING PHYSICS¹

THE college entrance requirements in physics have been such, at least up to the time of the recent modifications, that it has

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