THE STATUS OF THE PHYSICAL SCIENCES IN THE HIGH SCHOOL.*

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This is not a new theme. However, I believe it to be a live one. Much that has been said and written within the last few years concerning physics and chemistry, in fact sciences teaching in general tends to leave a bad taste in the mouths of those engaged in presenting these subjects. Perhaps they are responsible for the criticism falling on this phase of high school work. Perhaps the subjects themselves are not what was claimed for them; or again perhaps we are not on the right tack and have yet to work out a new method for each subject, following a new and commonly accepted point of view and utilizing the great possibilities which educators say these subjects possess. At any rate there are evidences that the sciences, and science teachers, are being adversely criticised. Often the charges are not specific, but abound in expressions which indicate that in some way the sciences are not meeting the claims made for them.

Much of the discussion of this subject has been precipitated by the 1901 report of the U. S. Commissioner of Education, which brings out the fact that since 1889 physics and chemistry have steadily lost in the percentage of pupils engaged in their study, whereas Latin and Algebra have gained. The statistics show that the per cent of total number of secondary students in public high schools taking Latin has grown from 38.88 in 1892 to 50.07 per cent in 1902; German from 10.43 to 16.25; Algebra from 48.93 to 56.15; Physics from 22.82 to 17.48; Chemistry from 10.17 to 7.37.

Commenting on this report the editor of the *Popular Science Monthly* for April, 1904, says after some defensive arguments: "Still there are reasons to believe that physics and chemistry as taught in the high school and college are not attractive to students. Indeed, we have grounds for fear that the high school course as a whole is not so useful as it should be, especially for boys."

Dr. G. Stanley Hall, in his recent work on Adolescence and in an address before the Eastern Association of Physics Teachers, said: "Despite its marvelous growth as a science, physics is now well along in the stages of educational decadence."

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At the last meeting of the Central Association of Science and Mathematics Teachers, held in Chicago, a paper was read on "The Decrease in the Number of Pupils of Chemistry in the High School—Its Cause and Remedy."

Supt. D. L. Bardwell of New York, in a paper before the Physics Club, said: "Within the recent past science has apparently been losing ground. Certain tendencies are working against science teaching since the introduction of laboratory work, etc., etc." This much, I think is sufficient to show us that we are under criticism.

The history of secondary physics and chemistry teaching is brief. Neither can lay claim to more than twenty years of trial in the United States, especially along approved scientific lines. Each has undergone a rapid evolution. Chemistry has grown from a study of a few gases followed by qualitative analysis of an unsystematic kind to a well organized treatment of general chemistry, including much laboratory work, some of a quantitative nature. Physics as a high school science is older than chemistry. It has grown from a strictly text-book subject of more or less indefinite purpose and called natural philosophy to a carefully organized and systematic study by text and experiment of physical laws and phenomena. Along about 1893-94 the sciences, and especially physics, received a great impetus in this country. This was due largely to the report of the committee of ten which so strongly recommended the study of physics in the high school. Many rash and absurd claims were made for it. It rather took things by storm. An immediate departure from classical courses resulted, and science subjects were substituted. At this time, 1893-94, the pinnacle was reached—25.29 per cent of all the pupils being then enrolled in physics. Text-book writers got busy and soon a number of books planned along various lines and with various purposes in view were placed in the hands of teachers, often poorly prepared to present them. High schools were demanding teachers of science and higher institutions were attempting to supply the demand, though just what was wanted was known neither by the school nor the college. Should it be surprising if science teaching suffered by comparison with the teaching of the classics, which has been in practice for centuries. It seems to me that of all the high school subjects the sciences require special preparation for their successful presentation, not the home-made kind, away

from all laboratory facilities. The teacher must have the scientific spirit if he will succeed and this is gotten by thorough and properly directed work in the laboratories of science. Little can be expected of a high school course in physics or chemistry if presented by a teacher who has had only a term's work on the subject. Add to this a poor equipment and, I say, Do something else—have spelling—don't be a party to the willful murder of the subject. Think of school authorities employing a teacher for German who has had a year's preparation in this language. They do not hesitate to give two or three sciences to the teacher who has prepared to teach not science, but history, mathematics or languages. I visited a high school this year in which an overworked teacher, prepared to teach mathematics, was conducting the work in chemistry. The work for the day consisted of a study of lime and calcium sulphate, according to some directions written on the board. The pupil was instructed to treat Ca SO_4 with HCl filter and set aside to crystallize. The formula for lime was written Ca OH . To my mind it would have been infinitely better if those pupils had had two recitations a day in mathematics, for the teacher did well in his line. Let's sacrifice breadth, if in attempting to give it we sacrifice both depth and breadth.

Concerning the report of the Commissioner of Education, it may be said that the whole truth is not revealed. During the time covered by the report, viz., the twelve years from '89-02, high school courses have undergone many changes. A prescribed course which every one had to take and which included physics and often chemistry has been replaced by one embracing a much greater number of subjects, many of them elective, especially in the last two years of the course where physics and chemistry are nearly always given. Chemistry is usually elective and physics often so. In these last two years, pupils elect half of their work from a list of subjects and are often influenced by the amount of work and time required by the subjects. Pupils like to do all their work in school. They know that laboratory work requires two periods in school and time to write up notes. The keeping of notes pupils usually dislike. Most of us did, even in college, where we recognized their value. Pupils will prepare a recitation lesson in one period and recite it in another and thereby finish the work in that subject for the day. Not so with a laboratory science subject.

It seems to me that the statistics are wholly inadequate for comparisons of growth, etc., due largely to the rapid evolution of the high school course in general and to the lack of uniformity in the content of the course. The statistics in no way show conditions like these. In a school of 100 pupils that I was formally connected with, chemistry was required in the junior year, and the class enrolled eighteen pupils. In the school of three hundred and twenty-five pupils I am in now, chemistry is elective in the senior year in which are offered as elective the following: Astronomy, German, Latin, History, Physiology, Botany, Physics, Chemistry, Mechanical Drawing, Free-hand Drawing, Higher Arithmetic, Music and Solid Geometry. English is required. The senior class averages about thirty-five. In all the larger high schools the number of electives increases yearly, thereby reducing the number in any one subject. Statistics that would show us the per cent of those that can take a subject that do take it would afford us a better basis for comparisons.

Concerning the criticisms of Supt. Bardwell of New York I wish to say a few words. He thinks too much time is consumed in the Physics Laboratory; that owing to indefiniteness of purpose and need of constant direction, one-half the time is not used to the best advantage by the pupils. They are not putting forth effort, and when not putting forth effort, they are not acquiring power. We will all concede that power comes from effort, but do we as teachers of physics get less effort than teachers of any other subject? Do we not get more? Supt. Bardwell says that for the entire preparation of a lesson in language or mathematics the pupil is required to think continuously and consecutively and this leads to power. How many pupils put in a period at close consecutive thinking in preparation of a lesson. Visit an assembly room and note the hasty flights from one lesson to another. How much of the work in mathematics and language is done on the co-operative plan? Even with the closest and most persistent vigilance, the teacher is powerless to prevent such division of labor.

Dr. Hall, in his "*Adolescence*," explains the cause of what he calls the educational decadence of physics this way: "Neglect and the violence done to the nature and needs of the youthful soul." He thinks more of the hierarchy of physics should be given; that the work is too quantitative, that boys should have more dynamics since they are chiefly interested in the go of things;

that very much thoroughness and perfection violates the laws of youthful nature and of growth, and that the high school boy is a utilitarian and should be given the applications of the science before the treatment of laws, forms and abstractions. The age of pure science he thinks has not yet come. The boy he says is in the popular science age and wants and needs great wholes, facts in profusion, but few formulae. The subject matter of his curriculum is too condensed; too highly peptonized for healthful assimilation; and we are too prone to forget that we can only accelerate nature's way, but never short circuit it without violence.

There is no question but that much that Dr. Hall says would result in good to the work if employed by the teacher, but there are many of us who will disagree with his idea of the general plan of the work. Entertainment is not the function of the work, nor is it the creation of an incentive to do some real work in the subject some day. Any subject should stand or fall accordingly as it does or does not give useful training, does or does not prepare for life. Dr. Hall says that for disciplinary value physics is unexcelled. The subject itself then is not on trial. The trouble so-called then is with the method. He would have more qualitative work, more of the historical and spectacular side of physics in order to arouse interest, thereby laying the work open to the charge that no training is given. Should quantitative work, the disciplinary value of which is great, be sacrificed simply because it is supposed to be less interesting than quantitative work? Is interest the object of mathematics or Latin? Interest is necessary in any subject, but it is only a means to an end. Physics is a difficult subject, not one likely to be elected by the lazy. I see no reason why it should be popularized by taking away the very things that give it great disciplinary value simply to increase the per cent of pupils taking it. Pupils will always differ in tastes and many would not take physics, no matter how presented. Those who do want it should be given the opportunity of getting it in a way that will both enhance complete living and be preparation for further work in some higher institution. I do not believe it is the function of physics and chemistry to arouse interest in the dull or lazy, though they frequently do accomplish this result and always will on account of the flexibility of the laboratory method which enables the teacher to diagnose and prescribe for the individual rather than the class. The goal is not the large per cent of pupils, but the satisfaction in

enabling some to discover their bent, in developing power through the agency of subject matter which has other pedagogical attributes than the educational means afforded. The informational side of these subjects is of no little importance in this age of invention.

Whatever improvements are made in the presentation of these sciences will be due almost exclusively to the efforts of the science teachers themselves. This association has unquestionably done the work much good. It is simply a matter of both individual and united effort. Let us hope for their continuation.

EXPERIMENTAL LECTURES.

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At the meeting of Central Association of Science and Mathematical Teachers last November a teacher, in discussing the high school fraternity problem with me expressed a wish that our high school buildings might become centers for student activities. Although the speaker evidently had in mind the social side of school life, his remarks called to mind a plan that we have been following for over a year, which involves the occasional use of the buildings outside of the regular hours. It is simply the giving of experimental lectures of a more or less popular nature to certain groups of our students.

They are valuable in the first place because there are many interesting topics in connection with our subjects which we have not time to develop during our class hours. In the second place, we are usually blessed with a few students who have a real scientific bent, and these lectures help to keep alive and to stimulate their tendencies in this direction. Again it is possible by this means to come in contact with our students in a pleasant manner. An evening hour spent in this fashion will often lubricate the mental workings of some members of the class who do not take naturally to mathematics and close thinking, and cause them to attack the text a little more vigorously. Also they bring us into touch with members of the school who are not in our classes, but who may be led by these sugar-coated doses to take the course in the regular allopathic manner. Another important service here is giving some students, who may leave school before reaching the advanced subjects, an idea of what science is. Furthermore, they