

GENERAL SCIENCE—ITS CHARACTER.

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Every demonstration rests upon a necessity. The necessity of a general science course is demonstrated by the national advertisers of the country. The Eastman Kodak Companies, the soap companies, the electric companies, the gas companies, the food companies, the manufacturers of household conveniences, and the automobile manufacturers are spending *tremendous* amounts of money to teach the general public to use efficiently and benefit by the products of their researches in the domains of physics, chemistry, biology, engineering, and other divisions and subdivisions of scientific import almost too numerous to think of.

Can one believe that they are so generous as to do this unless their efforts met with an appreciative interest and response? These advertisements are not theses beginning with the ionic theory and ending with push the button, but are psychological demonstrations teaching how to utilize the embodied conclusions of scientific progress for the *benefit* of the *purchaser*.

The necessity for teaching general science rests upon the fact that man does not and cannot create anything. He observes and studies the phenomena of nature, and learns to formulate her laws in order that her prodigal bounty may be utilized for the benefit of mankind.

The necessity of a general science course is also based on the lack of time to study the detailed causes of physical and biological phenomena or the reasons for the formulated rules. The laws, rules, and precepts that have been discovered and formulated by the great physicists, chemists, and biologists can be utilized even though the sequence of the underlying fundamental reasons is unknown. Thousands of people are taught to run automobiles who have no capacity to comprehend the remote sources of power in nature or the transformations of energy.

The pupil should have some knowledge of the tools of nature and also of what can be done with them. The general science course makes this possible. The physical sciences deal with the *forces* of nature as energy, heat and light, while the biological sciences show us the *effect* of these forces on *life*. General science tends to utilize the facts of these sciences for the benefit of man.

The *insistent* why in the minds of some pupils, which has

always been present and always will be, must be satisfied, however, and just as much of this abstract work should be done as time and the ability of the pupils permit.

The wonderful work done by great scientists is available, and one of the duties of general science is to teach an appreciation of these men and their work. Those pupils who show an inclination for delving into causes should be given the opportunity to become students of the physical and biological sciences.

Since general science rests upon a necessity, the purpose of the course is to meet this broad necessity, and the characteristics of the course should be based on the varied needs.

Many science teachers unquestionably would give as the purpose of a general science course—the desire that our young folks acquire a measure of scientific knowledge which they can use in everyday life. How much science these young people acquire depends upon the time allotted to the subject and also upon the year or years in which the subject is given.

At the school of Pedagogy, Thirteenth and Spring Garden Streets, an elementary introductory science course is creditably worked out during the eight years of grade work. These pupils, however, are so small in number that we must say practically all pupils entering high school have had no science work.

Now, these pupils need an elementary course in science to stimulate the process of reasoning—to observe first hand what is happening around them—to start the habit of thinking out answers and to begin to interpret what is seen.

The difficulty in teaching this course is to make it simple enough for the young mind to grasp, and to tie together a number of loose bits of information, observations, and facts obtained by tests and experiments, and to correlate them so as to make them stick and at the same time to build the foundation for the subsequent courses in the physical and biological sciences.

As I have said before, the purpose of a course determines its characteristics. When teaching general science, I have observed that it brings about a natural condition of the pupil toward his work, instead of a forced relation which so often results in languid and purposeless efforts. The reason for this attitude is that the pupil works from the known to the unknown.

Because the things in the world about can only be understood in reference to the intuitive or known conceptions in the pupil's mind, this course results in helping the pupil to correlate his life with the world about him.

It makes toward intelligent rather than learned people in after life. Graduation means the end of book learning for many people. Experience, practice, interest, and association are the only means of learning after that. By bringing about the correlation of the pupil's ideas with the things going on in the world about him, a habit has been established which is not so apt to cease, while any reference work which he may have done in connection with the course will tend to lead him to consult books for authoritative information on the subject.

The work in a general course appeals to the pupils. I know that the girls like the work because they can and do go home and repeat some of the experiments that they have done in the laboratory. This shows that they have got something that sticks. While taking the work, they are constantly bringing problems of the home to the teacher to have her help solve them. Applying knowledge practically appeals to old and young alike.

The adaptability of the course is extensive. Local conditions help determine the character of much of the work done in the course. In fact, any particular sections of the country or any marked peculiarity of a locality would determine somewhat the nature of the course. A boys' school would do different work from a girls'. Not only high schools for girls, but even colleges for women, have borrowed the science curricula from boys' schools and men's colleges, and made all the girls do work which was not relative to their interests or tastes.

Any group of boys taking a science course acquires a considerable amount of general science naturally, because boys somehow or other get around in shops, manufacturing plants, and various places where the why is always aroused, and if it is not answered on the spot, ten chances to one it is brought up with the class work either as volunteered information or in the form of questions.

The contrary of this statement is true of the girls. The girl who acquires any general scientific training outside of the school is the rare exception. On account of the great wealth of material for a general science course, boys and girls can have courses best fitted to their needs, and even particular groups of boys and girls can have special attention given them in the planning of their courses, since the purpose of the course determines the character of the work planned.

A course so planned helps to adjust a pupil to his environment, and gives him a broader basis upon which to select his avocation. I think there is need for such a course in the night

schools. It is quite probable that there are more colleges and universities where high school graduates can have the opportunity of specializing in some science than there are high schools where all the boys and girls can have a general science course which will help in the adjustment of the individual to the community.

Among pupils taking this general work, a teacher will always find a few who show the possibilities of doing creditable work in the specialized sciences; sometimes it will be a leaning toward the biological, sometimes toward the physical sciences. A general science course is helpful then in interesting to such a degree the pupils who possess the possibilities of developing into scientists that they continue their work in the specialized sciences.

A teacher of general science needs technical knowledge of the biological and physical sciences as well as practical experience in using this technical knowledge.

Because interest and enthusiasm are contagious, the teacher is willing to give of her time to help individuals who bring special problems. It is the exception for girls not to be able to do the work, and here is one of the strong points of the course, because pupils like the actual doing of things. This is a hopeful aspect for the teacher because she knows she is not up against an impossibility. The relation between teacher and pupil is healthful and stimulating to both. A teacher of a specialized science in changing to general science finds that she has new things to learn and a different point of view to acquire.

GENERAL SCIENCE—ITS RELATIONS TO THE PHYSICAL AND BIOLOGICAL SCIENCE COURSES.

In contradistinction to this *general* course, physics, chemistry, and biology are all specialized courses. The general course is the bread and butter for the pupil who is a pupil for the few years he spends in school. Physics, chemistry, and biology are the specialized articles of diet for the student who is a student from his first day in school until his graduation from the university. It is *all* food, and should be apportioned according to the respective needs. There are specific needs for a physical or biological course for some pupils.

Some of the divisions of the science of biology are botany, zoology, morphology, physiology, hygiene, psychology, sociology, ecology, paleontology, etiology, systematic botany and zoology, and economic botany and zoology. These subdivisions are of varying importance as regards meeting the needs of the pupil. As

the general knowledge of biology implanted by the general course can be applied to human welfare just so are the detailed teachings of biology of importance provided they become of use. I think the same is true of physics and chemistry but I shall leave this question for the chemist and physicist to decide.

The needs of detailed teachings are measured by utility to the pupil and adaptability for assimilation. I believe that just as much of specialized teachings should be given as the pupil can assimilate with benefit. Specialized teaching must have utility as a basic principle at all times.

I have endeavored to show that the teaching of *general* science and of *specialized* science is a question of *relative* necessity measured by utility.

OXIDATION OF AUTOMOBILE CYLINDER OILS.

The Bureau of Standards, Department of Commerce, has just issued a pamphlet, *Technologic Paper, No. 73*, giving certain data relative to the oxidation of automobile cylinder oils which has been made the subject of a recent study by that Bureau.

The rate of oxidation of three oils when exposed to sunlight and air was studied, and the increase in weight, acidity, and carbonization value, as well as changes in the Maumene and iodine numbers and in the demulsibility, were determined. Changes in the carbonization values of these three oils and of eight others, when heated for different lengths of time at a given temperature, and for the same time at different temperatures, were studied.

The bearing of the work of the Bureau upon the testing of oils is pointed out.

Copies of the paper may be secured free of charge by persons interested upon application to the Bureau of Standards, Washington, D. C.

PETROLEUM AS LOCOMOTIVE FUEL.

Figures just made public by the United States Geological Survey disclose a marked increase in the use of petroleum as a locomotive fuel by the railroads of the United States in 1915. The data at hand show that the quantity of oil fuel so consumed last year was 36,648,466 barrels, an increase of 5,555,200 barrels or eighteen per cent over the similar consumption in 1914. This increase is ascribed to the relatively low prices prevailing for fuel grades of oil during the last year and a half as a result of the increased production of low-grade crude in the Gulf Coast States and in Mexico and of the augmented output of suitable residuals from refineries operating in ever-increasing number in Oklahoma and Kansas.

The total distance covered by oil-burning locomotives in 1915 was 124,255,525 miles and the average distance covered per barrel of oil fuel consumed was 3.39 miles. Oil fuel is now used to some extent on forty railroads in the United States, having tracks in twenty-one States.