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The Project in Chemistry

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THE PROJECT IN CHEMISTRY

Some time ago the writer became convinced that the typical presentation of high school chemistry left many things to be desired, especially with that group who are completing their scholastic work with their high school diploma. As a rule they are leaving school pretty thoroughly disgusted with class work in general, and, although they had originally intended to continue in school as evidenced by their election of chemistry, they find that the prospect offers no allure. In many cases I am afraid that the course in chemistry helped to turn them from further scholastic endeavor. In order to furnish some stimulant to revive their interest the project method was tried.

For the introduction to chemistry the historical approach was used and the first project might well be labelled, "Alchemy." As this is being written there are before me five of the recent, widely-used texts, all but one of which employ this historical approach with varying degrees of thoroughness. It seems to me that it is exacting a good deal to expect the beginner to accept the statement that "chemistry is vital to all industry" when he has no idea whatever what chemistry is. It would seem that the best way to teach the above maxim would be to so present the subject that the student might well exclaim at the end of the course, "Where would industry be if it were not for chemistry!" A second justification of the historical approach lies in the fact that the method of study and the nature of the material to be studied is in many cases totally new to the student, although he is quite familiar with the reading of history. Thus he begins the study of chemistry by employing only those skills which he has already acquired.

The only new skill which the student was forced to learn was the use of the library and reference material in general. Although other departments attempt to teach familiarity with the various literature guides and indices the student has never really had to depend upon them for his entire material. In other words, he has not learned to conduct research in the field of literature, consequently the first teaching problem is the solution of this difficulty. In meeting this situation the writer prepared a brief bibliography of available material using the card index system and carefully went through this with the class, showing them how to look up material from the abbreviated references and how to develop the biblography by the addition of supplementary topics, synonyms, etc. This required several days, but the time spent was well worth while for after all one of the aims of the subject is to create a scientific attitude and I have found no better way to stimulate the student to research and to develop the questioning attitude than by widening their horizon through directed reading.

The second step in the development of the project was to arrange the work so that each student had a part in it. A few assignments were made for all to read and the balance of the material was presented by individual reports. Each topic was selected with the idea in mind that it would present some additional contribution towards the formation of the unified picture. The following represents some of the assignments:

For General Reading

"The Story of Early Chemistry" by J. M. Stillman.
Appleton, 1922. Selected readings.

"History of Chemistry" by J. F. Moore.
McGraw-Hill, 1918. Selected readings.

"Chemistry in Modern Life" by Svante Arrehenius.
Translation by C. S. Leonard.
D. Van Nostrand, 1925. Selected readings.

"History of Science" by W. C. D. Dampier-Whetham.
Macmillan, 1931. Selected readings.

For Individual Reports

Lives and contributions of some of the early alchemists and natural philosophers, for example:

The Egyptians, the Greeks, Hermes Tresmegistos, Geber, Galen, Albertus Magnus, Roger Bacon, Basilius Valentinus, Paracelsus, Agricola, Van Helmont, Glauber, Kunkel, etc.

Articles from various professional and current magazines, such as:

Alchemy, Jr. Chem. Ed., 2, 349 (1929).

Street of the Alchemists, Jr. Chem. Ed., 4, 467 (1928).

Past, Present and Future, Jr. Chem. Ed., 4, 486 (1928).

Textbook on, Jr. Chem. Ed., 3, 575 (1931).

Old Colonial mss., Jr. Chem. Ed., 12, 1583 (1928).

In New England, Jr. Chem. Ed., 10, 2094 (1931).

Mirrors of Alchemy, Jr. Chem. Ed., 10, 1945 (1931).

Symbols, Laboratory, 4, 40-1 (1931).

Posters

Pictures of early laboratories.
Pictures of alchemists.
Elements known to the ancients.
Symbols and significance.
Early apparatus.

Studies of early superstitions.

This is by no means a complete list but represents some of the topics from the author's file. A great many other sources exist available to us here, but the above should be available to most teachers of chemistry.

The culmination of the project was realized in the Chemistry Section program for the current meeting of the Science Club. This was made an open meeting and the public was invited.

Criticism might be advanced that the subject matter is slightly too advanced—the language of the discussions too technical for the beginner. This thought occurred to the author, but trial showed such interest developed that if there was any difficulty it was overshadowed by the enthusiasm. Displays of the various elements and compounds mentioned in the literature gave them an opportunity to become familiar with a number of substances, and demonstrations of the use of various pieces of apparatus removed any ambiguity in that direction. Natural interest in apparatus stimulated the desire to examine present day apparatus, furnishing a logical introduction to the succeeding work.

The class work following this project dealt with familiar elements and compounds and was handled as the ordinary class assignments accompanied by the routine laboratory dealing with mixtures and compounds, physical and chemical change, etc. With the study of chemical change the concept of the kinetic theory of matter is presented and with it the atomic theory and the modern theories of the structure of matter. A small project is here introduced dealing with models of the atoms and thus the student arrives at the significance of the chemical symbol. The gaseous elements are very carefully avoided up to this time since the majority of beginners have little or no idea of the nature of a gas.

There are several methods of proceeding from this point, namely: first, to take up the study of the gaseous elements, oxygen and hydrogen, and then water and with them the associated laws; second, to keep more within the realm of the students experience and begin with the study of the metals; and third, to begin directly with the study of water. I prefer the latter since it follows directly the historical approach, is familiar to everyone, and makes a natural step to the study of the gaseous elements.

The study of water adapts itself very nicely as a combined class and individual project and the following outline will suggest topics for student projects:

Unit II, Study of Water

1. Historical Importance.
   a. An ancient element.
   b. A barrier.
      1. To discovery.

2. To the dissemination of knowledge.
   c. A means of communication and transportation.
2. Physical Properties.
   a. Solid, liquid, and gaseous phases.
3. Use as a Standard.
   a. The Metric System.
   b. Specific Gravity.
   c. Temperature.
   d. Heat.
4. Use as a Solvent.
   a. Solution.
   b. Crystallization.
5. Composition.
   a. Purity.
   b. Electrolytic decomposition.
   c. Formation from elements.
   d. By weight.
6. Chemical Properties.
7. Purification.

The study of hardness in water and softening processes are left until the student has acquired a working knowledge of chemical reactions, usually during the study of the metals.

By this time the student is ready for an introduction to the gaseous elements and a continuation of the historical development of chemistry. Limited time and space prevent the presentation of the complete projects for the first semester's work but they are built around the chemists of the sixteenth and seventeenth century and consist of the study of oxygen and hydrogen and the atmosphere. Reports on the lives and contributions of Boyle, Priestley, Scheele, Gavendish, and Lavoisier give the foundation for the aforementioned projects and will also serve as a basis for the study of gas laws, liquifaction of gases, and related topics. It is the author's intention to present the whole course in project form some time in the immediate future as it has been so successfully used by him. Acknowledgment is hereby made to the many contributing authors in the Journal of Chemical Education and in School Science and Mathematics.

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Club programs built around the lives and contributions of great men of science can be made quite worth while and successful. The article in the present issue on "The Project in Chemistry" should be suggestive for club work if the teacher should prefer to make use of Mr. Pettit's suggestions in this way instead of in the organization of the chemistry course. Many clubs have had successful programs built around the life of Edison and his work. Projects and demonstrations illustrating his work with an exhibit could be carried out. The following material will furnish suggestions for an Edison program:

Moving picture reels: Thos. A. Edison (1 reel), The Benefactor (Life of Edison) (3 reels), Light of a Race (1 reel), Gen. Electric Co., Schenectady, N. Y. These reels are free. Also Bringers of Light (1 reel), Extension Dept., State College, Ames, Iowa.

An Assembly Program: Edison. Gen. Science Quarterly, May, 1928.

Edison's Part in Radio. Thos. A. Edison, Inc., Orange, N. J.

History of the Electric Light. Publication No. 2717, Smithsonian Institution, Washington, D.C. (Free).

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PROJECTS IN PHYSICS

The following list of Physics projects is recommended by the School Nature League sponsored by the American Museum of Natural History.

Home-made apparatus and models illustrating the principles of Physics. The title should state the principle or principles represented. The principle should be distinctly evident and clearly brought out by labels where necessary.

Simple machines, compound machines as in derricks, gears, transmissions, etc.; mercury barometer; model aeroplane with all parts labelled; model of a steam engine; model of artificial ice plant. Electrical apparatus as bells, transformers, motor generator set, model power plant, storage-battery, radio sets. Optical apparatus as refracting or reflecting telescopes, camera, projectors, etc. This list is intended only to be suggestive.