

with an experiment, so that I fear the whole work becomes an experiment and sometimes a serious one. People who know little or nothing of science will cry out, Experiment, experiment; nothing is to be learned but by experiment--the only true way to acquire any real knowledge of an experimental subject is to go to the laboratory and experiment. Now this is true in a sense but not in their sense. Another says: "I am so fond of chemistry; the experiments are so beautiful and so interesting." True, so also to many people is a 1st of July celebration or a common picture gallery or an amateur concert.

Students, when they first enter the class of chemistry, and are lost in admiration of the wonderful sights there displayed, are inclined to sing with Croft: "My wandering soul is satisfied." But when the novelty begins to wear away and the real nature of the subject to reveal itself, they feel that the experiments were like the auroral display of the morning which ushers in the weary labours of the day. If any one thinks that a mastery of chemistry or physics or any other experimental science consists in a knowledge of its beautiful experiments, he has not even come to understand what constitutes a science. As well might we suppose that a critical knowledge of Shakespeare was to be obtained by studying the beautiful pictures in some voluminous illustrated edition of that author's works. If we take away the display of pyrotechny and acoustics often accompanying a chemical experiment, what does it teach? That under certain conditions a certain result is realized. But that these conditions are not always easy to fix appears from the fact that the best of experimenters will sometimes fail through a slight inadvertency. At the best then an experiment gives us an isolated fact; for any variation in the conditions

may modify or completely prevent the expected result. An experiment gives us no prophetic power, for we can never know, without actual trial, what another experiment, differing from the first only in details, may bring forth. But facts amount to very little in themselves. To be educated in a subject is not merely to know its facts, but to know the understratum upon which the facts lie. To know an experimental science we must know the laws which bind its facts together into a whole—we must be able to give a reasonable explanation of its phenomena, and to conjecture with some degree of certainty the outcome of some untried combination of circumstances. How bewildering and useless were the facts of astronomy until Newton framed them into a system and established the true theory of the universe in his law of gravitation; or those of geology until Lyell harmonized them by his theory of continuous geologic change; or those of biology until Darwin gave an insight, even though imperfect, into their cause by his now famous theory of evolution.

A science needs theory—a long experience in teaching a science taught me that experiment alone cannot impart a knowledge of science, and that experiment at random unites utility to amusement to about the same extent as a game at base-ball. The true way to teach science is to lay down the accepted theories of the science, and to employ experiment for illustrating and establishing these theories. The theoretic *must* precede the practical and the experimental if any real progress is to be made in the knowledge of a science. But, you say, the theories are drawn from experiments, and rest wholly upon them, and how then can you speak of theory preceding experiment? Yes, theories are built upon the results of experiments, and for that very reason I will venture the assertion that no boy and