SOME PRACTICAL PROJECTS IN TEACHING PHYSICS

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Physics deals with so many things connected with our home, school and community life, that if it is presented in a practical, rather than the usual cut-and-dried way, it is both interesting and instructive to our youth. Half a century ago there were fewer inventions and up to date conveniences, so the people of both city and farm were able to become acquainted with the limited number of things belonging to the field of science. The few conveniences then were learned easily at home, and the people were relatively more efficient than now. But inventions during the last half century have multiplied so rapidly that the home has been unable to keep up with them, so that the burden of making our youth efficient has fallen more and more upon our schools and colleges. These institutions as a whole are failing in much of this efficiency work.

Listen to some of the adverse criticisms of science teaching that are offered: "School work, especially in science, is too artificial—not real." "Most of the science subject-matter taught remains unused, both in and out of school and college hours and in after school years." "The big problem of the school is that there is very little relationship between the work of the school and the work ot the world." "Our physics books are too much on the order of encyclopedias or dictionaries, and their proper function is for reference only." "We lack books for high school and college which present science as living projects." "The basic error in science teaching today is that it does not center itself about the interests and desires of the students."

One of the professors in Columbia Teachers College asks and answers this question: "Why do we, as mature people, go to the literature of the automobile company to learn about the workings and methods of repairing of our batteries, and to make other repairs, rather than to a physics text book? Simply because the company's literature satisfies us, and explains in a practical, instructional way the workings of the battery and other parts, and touches closely and appealingly to the project we have." "We must remember," he adds, "that students are immature men and women and do not enjoy studying dry, unrelated facts, principles, theories and fundamentals any more than we would."

Why not bring small samples of real life and real workable problems to the school and college more than we do, and give them as projects—those which will appeal to and grip the student? This will not only interest them and show the worthiness of physics, but it will develop their thinking power. Dewey says that "there is no thinking without a problem. When judgment is challenged to face a dilemma it makes a fork in the road and thinking begins here."

I grant you that there are difficulties in the way of teaching by the project method, such as large classes, lack of suitable projects, the time factor in the teacher's and student's busy life, lack of trained teachers, lack of equipment and supplies, etc. Yet many science teachers in high school, normal school and college are doing work of this kind, and our plea now is for many more teachers to tackle the problem and thus give students worthwhile opportunities of studying science in practical ways.

Since time for this paper is so limited, I will confine myself to one phase of work in physics, namely, some practical projects in electricity. A few years ago while teaching a small class of high school boys we took up some projects in electric wiring. Several small, roughly boarded rooms in the manual training department served our purpose. Only three sides and ceiling were boarded, leaving the front of each room open. In these rooms the students worked out in detail a number of projects in electric wiring of homes, such as door bells, call bells and lighting. The interest was keen, thinking was stimulated, and the results educationally were good, even though not all of the individual work was neat and perfect. At other times practical electric burglar alarms for windows were worked out and some students installed them in their homes.

Electric dry cells are easily made, though they may be weaker than boughten ones, by taking apart old dry cells and using the zinc container and carbon stick, and packing a new pasty mixture of chemicals around the carbon rod in this container. This gives the student an intimate knowledge of the construction of such cells. A strong wet cell, which students enjoy making and using, can be constructed with a cup of water in an eight ounce bottle, a teaspoonful of potassium bichromate and a tablespoonful of sulphuric acid. Carbon and zinc rods, with wire attached, complete the cell.

With such cells a usuable medical battery, or shock coil, can be constructed, using a simple switch, a buzzer for make and break, and two pieces of coiled metal attached to wires to hold in the hands.

A miniature home lighting system is a good project. It is made by mounting several sets of lamp sockets on short boards, each set representing a separate circuit in the house, and these all connected to the main line with switch and fuse plugs. If a watt-hour-meter is at hand the cost of using each lamp or circuit may be ascertained by the students.

Again, the students may mount more lamp sockets on a board, having adjustable connections or switches between them so that the sockets may be cut out or cut in at will, and thus a handy lamp-bank is ready for a number of experiments.

Since students occasionally burn out valuable instruments by using wrong connections, they ought to equip themselves with a small fool-proof switchboard which tells at once whether their connections are right or wrong. Having learned the right connections to make with this small switchboard, practically all danger of burning out valuable instruments is avoided.

After electromagnets have been made and tested our students have put them to practical use by making simple telegraph sets and sending messages to each other, either in the laboratory or by installing the sets in their homes.

The making of induction coils, spark coils and other parts of wireless outfits are good projects. Not only do students of physics make most of their wireless apparatus, but boys who never have had physics are doing it. I feel sure that anyone present can relate instances of keen interest shown by students when allowed to make, or assist in installing, a wireless in the school, or when making their own outfit at home.

To mention briefly a few other practical projects in this branch of physics, I will suggest that the electroplating project, such as copper plating and nickel plating, be given. Let the students assemble the apparatus and actually plate things. Electrolytes and ionization are taught much more easily after a first-hand acquaintance with electroplating. Different solutions made with distilled water, using in turn salt, acid, sugar and glycerine, may be tested for conducting power, thus showing ionizing and non-ionizing substances.

Why not begin the study of the storage battery by having the students construct simple ones with pieces of lead, a pint fruit jar and dilute sulphuric acid? After charging and testing this storage cell by ringing bells, the construction and workings of the regular battery will be understood more easily.

Interest and profit are gained by having students make Geissler tubes out of old electric light bulbs. The glowing, rarefied gas in such bulbs stimulates interest in another line, and may well lead to the mysteries of X-Ray production.

Making arc lights, using home-made electromagnets to draw the carbon sticks apart when the current is turned on, teaches the principles involved in street lights and lights used in stereopticon lanterns.

Continuing from this the electric furnace may be constructed, using electric light carbons enclosed in hollowed out fire brick, or in a box lined with some refractory material.

Recently our students obtained some wire of high resistance and worked out a number of interesting projects. One was an electric heater, capable of heating a small room. A piece of sheet aluminum was cut and shaped into a reflector, and the heating wire, wound around an asbestos covered porcelain tube, was mounted in front of the reflector. Some more of the same wire, mounted in six separate coils in the bottom of an asbestos lined shallow box with metal top, made a serviceable heater that could be used as a foot-warmer, or moderately hot stove or toaster. One student wished to make an electric flat iron. He did so by using some of this resisting heating wire inclosed between suitably insulated pieces of lead for weight. He covered it all with sheet copper, and fastened on a wooden handle. When connected to a 110 volt circuit it worked well. Surely college and high school students are interested and benefited in doing such practical work.

A little more ingenuity is required for making a Tesla Transformer which will give a 6 to 8 inch spark, but our students have done it after having had an introductory course in electricity.

When other projects are scarce a little time may be spent profitably in making blue print paper and then taking permanent pictures of magnetic fields about magnets and about current bearing wires. Also simple detecting galvanoscopes, electroscopes and electrophorouses may be made by students and experiments performed by using them in preference to elaborate and expensive apparatus.

I will mention in closing one other example of project work, and that is in the field of repair work. When some apparatus is out of order, if it is not too delicate and complicated, we give it to capable students to repair. They enjoy such work and often get much out of it, since they must learn how the apparatus is constructed and the principles by which it works. To mention a concrete case—we have an electric washing machine in our laboratory for demonstrating one use of the motor, and some time ago it failed to work properly. Some students took the motor off the machine, dissected it and found that a loose screw had caused a short circuit and partly burned out the armature.

Since we have not the facilities as yet for winding motors, we had the armature repaired at the factory; then the students assembled and installed it on the washing machine, making the rather difficult adjustments with ratchets, and the satisfaction of putting the whole machine in good working order again was worth while.

I am sure that you can suggest many more practical and instructive projects for students to do in the wide domain of physics, both in elementary and advanced work, and you who have done some of this kind of teaching know how it enriches a course, and makes the student exclaim "That was the best science course I ever took. I got lots out of it."