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TEACHER TRAINING IN DEMONSTRATION TECHNIQUES*

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One of the problems a teacher of physics must face each year is that of inventorying laboratory and demonstration equipment and preparing an equipment requisition and budget. New equipment must be ordered, old equipment repaired or replaced, and unusable equipment discarded. For an experienced teacher this can be difficult, but for the first year teacher it can be discouraging. Usually his experience with equipment has been restricted to laboratory experimentation accompanying course work. His knowledge of demonstration equipment may be slight, perhaps limited to that acquired from demonstration lectures he has seen, or from a superficial survey in the traditional methods course. He may have little or no knowledge of equipment companies, their services and the estimated costs of such services, and the relative merits of their equipment. His lack of experience limits his ideas for effective make-shift or home-made equipment.

In making out an equipment budget, the teacher, whether experienced or not, is immediately faced with this question: Considering the equipment and money available, what is the best teacher-learning situation he can purchase in the way of effective demonstrations and laboratory experimentation?

Mr. R. W. Lefler, at Purdue University, in an attempt to supply an answer to the question, established it as the major objective of a course entitled "Demonstration Techniques in Physics." Mr. Lefler is director of the teacher's workshop in the Physics Department, and as such provides co-ordination between the Physics and Education departments in the University, and teaches the "professional" courses required in the physics teacher training curriculum at Purdue.

With the major objective in mind, the following minor objectives of the course were listed:

I. To acquaint the student with as much of the commercially available equipment as possible, in view of effectiveness, construction, versatility, cost, and distributor.

II. To acquaint the student with the possibilities of building "special" equipment locally, in the classroom or shops.

III. To acquaint the student with the possibilities of devising demonstrations by assembling standard equipment such as beakers, flasks, glass tubes, etc.

IV. To acquaint the student with some of the sources of ideas, such as books, periodicals, equipment company catalogues, charts, pamphlets, etc. and,

V. To acquaint the student with the services of supply and equipment companies, such as the repairing of equipment.

The class was made up of 15 students on the second-semester Junior or Senior level, and met in 3 two-hour class sections per week. The text required was Sutton's *Demonstration Experiments in Physics*, McGraw Hill, 1938. This text was required since it was felt that every physics teacher should own a copy and be familiar with its contents. The subject matter outline and teaching suggestions found in the Indiana "Guide for High School Physics Teachers" were used to divide the subject of physics into usable sections for daily use, and to augment the material from Sutton.

The teacher's workshop is a large classroom-laboratory. It contains a library with a large number of secondary school texts and manuals in physics and chemistry, professional volumes, equipment catalogues, periodicals, and many general interest volumes. There are reagent shelves and a sink, work benches and tables with power and hand tools, and storage shelves stocked with a large amount of commercial physics equipment, much of which was donated to the workshop by the Welch Brothers Company. Over several years a large amount of home-made experimental and demonstrative equipment has been collected. Small parts such as screws, nails, wire, salvaged parts of all kinds from war-surplus equipment, and an adequate supply of raw materials are available.

During the first class meeting, the objectives and procedure of the course were explained. The students were asked to evaluate the equipment, demonstrations, and ideas encountered, by making notes in Sutton, in the outline or in notebooks. It was suggested that they formulate their own opinions as to what constitutes basic equipment, and to continually revise this opinion as the course progressed by weighing the respective merits of the equipment.

The class meetings for the early weeks of the semester were conducted in the following manner. For the next unit in the subject matter outline, all the commercial equipment available was displayed, and home-made or make-shift "special" and "assembled" demonstrations and experiments were prepared.

"Special" equipment is home-made, and usually of more permanent construction. It may be used to illustrate one concept only, and usually used only once a semester, or it may be a balance or indicator used for many purposes. "Assembled" equipment is put together from beakers, glass and rubber tubing, and other standard equipment found in any laboratory. The "racing rollers," for instance, can be home-made and are "special" equipment, while a calorimeter made of two different sizes of glass beakers separated by glass or rock wool is an "assembled" piece of equipment.

The first part of the two-hour class period consisted of an informal discussion of the equipment by the instructor and the class. Some equipment was demonstrated, some merely shown, but all was discussed as to construction, operation, cost, apparent effectiveness, and distributor. The latter part of the meeting was given over to the students, who were
free to handle the equipment, ask questions of the instructor or assistant, and to make any notes they wished to make.

Daily preparation consisted of studying Sutton, the periodicals, catalogues, texts, and laboratory manuals in search of ideas for demonstrations and experiments. Their own notes and ideas, from this reading and from the equipment demonstrations, were to be used in the latter part of the course.

After the outline for mechanics, heat, and light, and the respective equipment had been covered, the classroom became a workshop. The students were to make use of their readings, ideas, and experience to devise and make demonstrations of their own. "Special" and "assembled" equipment could be designed, and built or assembled. On occasion and approval, changes or additions could be made on the commercial equipment. Damaged or inoperative equipment could be repaired.

When a student finished a project, he demonstrated it to the class much as he would to a high school class, however, with the additional requirement that he justify and explain the equipment to his fellow class members. It was discussed and criticized constructively and destructively.

The same procedure was carried out the second part of the semester with the subjects of Electricity and Magnetism.

The evaluation of such a course is always difficult. However, it was felt that the general procedure was partially justified when the first fifteen students offered no suggestions for major changes. The interest and enthusiasm shown by the students were both amazing and gratifying. Many students voluntarily appeared for odd hours to assist in the setting up of the apparatus, realizing their own weaknesses, and the value of such experience.

It was found that some of the students were very backward in their knowledge and experience with common workshop tools and techniques, even to the cutting of glass tubing, fire-polishing, planing of wood, and many other similar operations. At the end of the semester, each student could drill and tap a hole, and do many other similar simple operations.

Part of the value of such a course lies in the fact that it comes rather late in the training of the future teacher, at a time when he is ready for practice or student teaching, and possibly already concerned with finding a teaching position. This familiarity with the tools of demonstration and experimentation, and his consciousness of its possibilities makes the following methods and practice teaching courses of much more value than possible otherwise.

There are some restrictions to the course taught in this manner. Not all schools are equipped or prepared to teach such a course. A classroom-laboratory such as the teacher's workshop is needed. It would be very difficult and inconvenient, if not impossible, to have the students scattered to different shops and rooms. It was found that two instructors were kept busy with the fifteen students during the class and laboratory periods.
The experimental procedure required a great amount of time for preparation of equipment. Often this time will not be available. It seems quite possible that the procedure could be modified, with the students doing a greater part of the preparation. This would result in less laboratory or workshop time. The procedure for any given semester in any school would have to be determined by the facilities and time available.

If these restrictions can be eliminated by making the classroom-laboratory, equipment, and time available, a course conducted in this manner offers definite advantages over the more conventional courses.