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During the fall semester of 1969 I had occasion to try some elementary science units with a low group of ninth graders. Of the units tried, the E.S.S. "Batteries and Bulbs" had such interesting results that it instilled in me the idea of trying the unit with my regular ninth grade class.

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In the previous group, motivation had been a problem, but with the average classes this had not been a problem. To clarify, the "average" classes have an average IQ approximately one standard deviation above 100. I would account this high average to the fact that the school is located in a university town and many of the student's parents are either connected with the University or the University Hospital. Unlike the low group, these groups had not been passive but rather had been quite active in all units thus far this school year.

In preparation for doing this unit, the students were given an intensive laboratory-oriented unit in electrostatics. Goals were designed in such a way that the students were compelled to trace charges from one body to another. Transfer of charge by induction and conduction were stressed, as well as the general rules of repulsion and attraction. To stress the concept of a force field, a demonstration was given using the cathode ray tube of an oscilloscope. This worked quite nicely to show both the attraction and repulsion of the electron beam. By the student reaction to this demonstration, I would judge that it was the first time many of the students had a real "feel" for what electrons are.

When they began their first exercise in "Batteries and Bulbs," I was quite surprised by the first group as only a couple of students had any success. This first exercise was to take one battery, one bulb, and one wire and light the bulb as many ways as they could. Remembering back to my low group, most of the class was able to light the bulb a couple of ways by the end of the first class period. This still puzzles me and I do not have any reasonable explanation. The next two groups to try the first exercise had similar results to the low group, that is, eventually most of the class was able to light the bulb a couple of ways.

From the first day onward I had a list of activities posted that they should eventually do. This turned out to be a good thing for here again, as in the low section, some of the students were much faster than the others and could move on to the more complex materials.

It may appear to the reader that I had set out to disprove the validity of low grouping by the continuing comparison of the two types of groups, but this is not the case. However, when we look at the way the average group handled the wiring of switches into a circuit a comparison must again be made. In the wiring of a three-way switch the low group had achieved success of 90 per cent by the end of the second day, whereas the average groups were only about 50 per cent successful in the same period of time. In the low group there was no success the first day, but in the average group one girl completed a workable circuit near the end of the first day. This particular girl has an IQ of 140+. One thing must be pointed out on this particular exercise and that is, the size of the class permitted each of the students in the low group to have his own equipment, whereas, the average groups had at least two individuals to a set of equipment.

Rather than go through each exercise that the students experimented with I will include one more and then make some general observations that were gleaned from working closely with the students for seven weeks.

During the venture into magnetism, one of the goals was to plot the strength a magnet has at various distances from the magnet. For this one, it was up to the student to design the experiment and collect the data. A few students came up with some basically sound ideas, but the majority of them bogged down. I hesitated to aid very much since some had success, but if zero production goes on for too long then I feel something is lost. I did wait two days though and the interest was still high until about the middle of the second day. After a few hints as to some possible methods of gathering data, they were off and working again and I don't feel as though I stifled their inquiry too much. The methods I proposed still needed some refining before they were workable.

General Observations

1. The more nebulous the laboratory goal, the less active the students are and the shorter is the period of time they investigate.
2. The infrequency of testing did not dampen the students' enthusiasm for investigation. I also did not see any evidence that it enhanced or accelerated investigations.
*3. Students did not refer to books to aid them in pinning down the goals, even when specific pages were listed to help them.
4. With the basic information mastered by the students, they were able to move on to other exercises without difficulty. Along with this there were

These are the items that confused me the most and would require more study before general statements of any value could be made.

some that did not understand the basics until they had done other more advanced exercises.

5. Since this was a relatively self-pacing unit, the students that were absent were able to catch up to some degree if they wanted to.
6. In the past, the laboratory exercises in electricity were dull for the students after a couple of weeks. In "Batteries and Bulbs" the students' interest stayed relatively high for the full seven weeks.
7. The design of the equipment for the unit enables the student to see where all electrical connections lead.
8. The term "short circuit" was used for anything and everything that went wrong.
*9. With the generic build-up of circuit tracing one would think they would be somewhat systematic about designing a 3-way switch, but most were not. Instead they reverted back to trial and error methods incorporated in the very first exercise.
10. Many of the boys with electrical experience in Industrial Arts did no better than those who had no previous electrical experience.
11. More students came in on their own time to manipulate apparatus than had before on other units.
12. Some very bright students were very frustrated when they were unable to do a laboratory exercise that others found to be easy.
13. For being designed for the elementary grades this E.S.S. unit was very well accepted by ninth graders. In fact, the students that worked the hardest were the ones that were usually at the top of the class in other units. Not only did they work toward the prescribed goals, but went beyond on their own initiative.
14. There was a small group in each class that found it was pretty easy to let the others do the investigating, but this could be corrected by having equipment for each student.
15. Questioning of "spectator" lab partners usually showed that they were inactive mentally as well as physically.
*16. One boy in particular came out of his shell and *actively* participated in laboratory for the first time.

My general impression now, after having experienced "Batteries and Bulbs" with the full range of ninth grade students, is that it is a very good unit with few trouble spots.