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For many years it has been a common practice in junior high schools to group children according to their ability. In the science class, as well as in the other areas, this has had its advantages and disadvantages. To motivate the student in the low group is a different type of problem than to motivate the students of the average- or high-ability group. Here you have a child, say in the ninth grade, who has been placed with others that he knows are inferior as a group. More than likely he has had a "watered down" version of what the higher groups have been taking. In general, he expresses himself poorly, has difficulty in reading with comprehension, and has very little interest in what school has to offer.

Since motivation is such a problem with the low group, I have been trying various teaching techniques to keep them interested. Demonstrations quite often were about the best to keep them attentive. However, they were usually passive rather than active. That is, the teacher had to make too many of the inquiries while the student just sat there and received. The laboratory approach would seem to be the answer to get them active, but for most of the lab activities, they just were not that interested.

In the past few years, some excellent science programs have been produced for the elementary schools. Some are highly structured and some are highly unstructured. By chance I started trying some of the exercises of the unstructured programs. Even though the exercises were geared for elementary, they worked very well. The students began asking themselves questions and started some investigation on their own.

Very possibly, the reasons the elementary program techniques are so successful with this type of group are that the child has a goal that can be achieved and that he is being taught at a level where he "is" in his development rather than where we want him to be.

For the reasons given above, I decided to have the students do some exercises from elementary programs and lead them as far as they would go. Since the group that I have has only eleven students to begin with, I was also going to keep close records of individual progress. This keeping tab on individual progress was achieved to some degree by observ-

ing how they would attack the problem and if they achieved the goal they set out to achieve.

The students in the study had had one semester of earth science during the seventh grade and one semester of biological science in the eighth grade. Both courses were content oriented with one to two laboratory periods per week. They were a low-grouped section in which the grouping was based largely on nationwide test scores and teacher referral.

The classroom in which they meet daily has an area of around 900 square feet and a perimeter lab that would allow six feet of counter space for each student. If the student tables were included there would be twelve feet of counter space per student.

The study lasted five weeks and was laboratory oriented for the full time. This was a relief to about half of the students because reading is difficult for them. In fact, two of them are severely handicapped as readers and none of the others was above average. Testing was not emphasized other than their own effort toward achieving a goal. During the laboratory session, I had ample opportunity to discuss with them on a one-to-one basis. From this close contact, I was able in some degree to determine whether or not they had an understanding of what they were doing. Also, all inferences drawn were from observations and discussions while the student was performing in a laboratory situation. Mainly the study was to gain personal insight into the needs of what I call the disadvantaged student in the physical science program.

The activity decided upon for the session was drawn from the Elementary Science Study with emphasis on the unit entitled "Batteries and Bulbs." Prior to this we "dabbled" in the building of various structures with soda straws and clay. Then an enlightening session of building a floating device out of clay.

For the clay boat exercise, each student was given 50 grams of clay and given the task of making it float. After they got it to float, they were to see how much it would hold up before it would sink. Most of the students made a cup-shaped object and after a few minutes had them adjusted in thickness and depth so that they would float. The big point of this exercise came when the student tried to make it hold more weight. At first they were just playing, but when some started having success with 40 to 50 grams, enthusiasm picked up and everyone tried to do better. One boy became the main attraction making a deep thin-walled vessel that eventually held over 200 grams. Three others, after seeing the 200-gram model, were able to get their own to hold over 100 grams.

A drawing of the clay boat that did so well

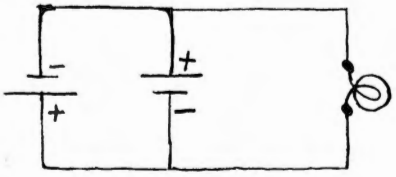
After such enthusiasm I decided that the next two classes, which were average and above, would get their chance at this clay boat exercise.

Things were approached in the same manner as the low group. In these classes there were at least a dozen who had shown fairly good manipulative abilities while in the laboratory. The results speak for themselves in that most of the boats would only take up to around a 50-gram load. An important happening that I am still pondering is that nobody even approached getting it to hold 200 grams. This leads me to speculate that possibly, if grouping is to remain, that extra criteria should be involved in selecting where the students are placed, other than by written exams.

At the beginning of a study, this was a moral boost for me that here in this low group there were resources yet untapped and hidden.

The next selection of study was with batteries and bulbs. As described by the E.S.S. *Batteries and Bulbs,* the students were given a flashlight battery and bulb and a piece of wire. The goal in this case was for them to light the bulb as many ways as they could. Three or four students found two ways immediately and within the hour. All but two were able to get the bulb to light in at least two ways and had drawn the type circuits that would work. For the two who couldn't get the bulb to light, I showed them that the light would work and a hint as to their orientation. For the one student who couldn't get it to light, this had been the longest he had stayed with any problem. It was probably the knowledge that the goal was within reach that kept him going.

The next step was to give them another battery and let them find the various ways they could get the light to work. Most of them realized the light was brighter for one type of hookup than another, but few saw much wrong with trial and error at this stage. For this reason I decided that we should go back to just one battery and do some circuit tracing and make sure that the electricity had a path. Then we had a quick exercise with the students drawing the circuit that could be wired by somebody else. Then we proceeded again to the two batteries and one bulb. This time when they approached the problem they were much more systematic and met with success much sooner.



A common error in two-battery hookup

One single-pole, single-throw switch was introduced and the students were to wire everything so that the light could be controlled with the switch. I jumped to conclusions that this would only take a few minutes when really they played around with this for a couple of days.

For the next few days they used their batteries and bulbs as testers for continuity checks. Some were systematic and did not repeat identical items, but a few were testing similar items over and over and seldom took shortcuts. This led to the hidden circuits within a box. By this time the activities were spread out by about

two weeks. That is, some were circuit tracing and some were on the two batteries and all of the areas in between. Some of the spread was due to the high absentee rate of a couple of the students and some to the ability and desire that they had for this type of activity. I had the students who were ahead of the others do excursions such as build circuit boxes, make a display of a cut-a-way lightbulb, cut open batteries, or trace more difficult circuit boxes.

The last exercise of the study was for the students to take two single-pole, double-throw switches, one battery, one light and wire it like a three-way switch in a home. That is, the light can be turned on or off independently from either switch. Many combinations were tried and frustration got the best of a couple of them. By this time they were circuit tracing quite well, but they could not quite seem to get it to work. Even the boy who was usually far ahead of the others was having difficulty, but he was very methodical just the same. At the end of the second day, they started getting the right combinations, but it was hard for them to copy each other due to the distances they were apart and also the maze of wires that were criss-crossing. Finally they all settled on one of two patterns.

The following day after they had all completed the wiring once, I had each individual wire it again and trace the circuit or where the electricity went. After they had traced it with various combinations of the switches to show me that they had an idea why it worked the way it does, I had them just play around with the equipment to see what other combinations worked.

The last day of the study consisted of them coming to me individually and trying to correct a three-way switch setup that had been wired correctly with one exception. This exception was a shorting wire under one of the switches. This made the circuit work correctly some of the time.

The responses fell into four categories: 1) One boy, the one who had excelled all along, looked at the circuit and immediately turned the switches over. When asked why he had done that, he said, "It was wired right, it had to be something else." 2) One student tried trial and error and then the last time, when one of the patterns that should work failed, he turned the switch over. 3) Four of the students circuit traced with various combinations and said that it should work because it was like it was before, but ended there. 4) The remaining group was strictly trial and error with no conversation indicating that they even saw anything wrong.

GENERAL OBSERVATIONS

1. When the students had a definite reachable goal, the interest level was high, but when the problem was too difficult the interest waned rapidly.
2. Even though this was a homogeneous group, there was a very large spread in abilties within the group.
3. Many of the students hurried to keep up with leaders of the class even though they were assured that they could take as long as they wanted.

4. More intensive work was done when the students were separated by large distances than when they were allowed to be close.
5. When working in close proximity of one another, the girls had more of a tendency to help one another than the boys did in helping each other.
6. Two of the students in the study who had been producing very little in the time before the study began to work—one of them immediately and the other during the third day of batteries and bulbs.
7. Observing the enthusiasm, in contrast to their passive attitude before, I am led to believe that something is being done wrong to these students. Either the way they are grouped or the method with which they have been taught.
8. It was difficult to keep the more able students busy because of vast differences in the rate at which the students worked.
9. The rigging of the three-way switch indicated which ones had really structured in their own minds the idea of circuit tracing and what a continuity check tells a person.
10. Some of the students appeared to be misgrouped.
11. Laboratory procedures were welcomed by this group for this type of activity.
12. In the beginning the students asked about testing, but toward the end when they realized they were not going to have any, they stopped being concerned about preparing for oncoming questions.

This study did not discover any overall answer for the child in the low section, but it did point out that things could be more exciting for them. When they begin structuring their own thinking by starting out with the basic materials and are allowed to manipulate them at their own rate, things move along very smoothly. Also, with such a large range of abilities, this type of activity with the type of excursions available does provide for individual differences. With this study being such a success, the next step is to try more of this type of material and even in the average sections. Maybe more students in those sections will also become involved.

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