RARE CATS 2000
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Research Vignette: The Alien Detector
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The students are about to start the study of electrostatics in an Advanced Placement Physics class. How do I make it interesting and get the students involved in a subject that they cant see? What do I mean by "they can't see"? Often students say that the study of mechanics in physics is easy because they can "see" everything that is happening. For example, they can "see" a car moving, accelerating, and slowing down. But, they can not "see" an electron, the buildup of charges on plastic charging strips or the removal of charges from the charging material. What can I do to help them "see" these charges?

Back in the fall of 1999 I found an Internet article, Ridiculously Sensitive Charge Detector, written by William J. Berry at: http://www.amasci.com/emotor/chargdet.html. Fran and Nicole, two of my more enthusiastic AP students, decided to built four of the detectors and see if we could use them in the class. The AP class played with the detectors and had problems with them working, burning out the transistor and the Light Emitting Diode (LED) and the batteries keep going dead. I asked for suggestions on how to improve the detector so that it would work better in a classroom. Fran suggested that we could add an ON/OFF switch so that the battery would not go dead. It was decided that I should purchase a small circuit board, a small electronic project box, a 9-V battery connector and an ON/OFF switch. Fran took on the job of building the new and improved charge detectors. He drilled holes in the box, mounted the switch, and set it up so that the LED would stick out of a hole. It worked so well he built five detectors .

Now how could I use them in the course? After the RARE CATS institute at Greenbank, WV and working on group projects and looking for aliens with the radio telescope it hit me. Call the detector an Alien Detector and let the students figure out what the box did on their own. Thus, in July 2000 the Alien Detector idea was born. Fran and I checked out the detectors when school started in the fall. He was sworn to secrecy and we were ready to go.

The problem was written. "Recently two Men in Black were seen at the high school. They left behind a small box labeled "Alien Detector". Your team's problem is to find out what the box really does." The students would be required to complete a written report on their findings and present an oral report to the class in one week. As the class was finishing up a section on vectors I brought out the boxes, handed out the directions to the three member teams, and the search was underway.

Does it detect temperature? Does it detect light? Does it really detect aliens? How does it work? Did Fran build this? These were just some of the questions asked by the students. Then there were questions by students in other classes and even the high school faculty. The little black box generated a lot of discussion throughout the building because the students were carrying the box around to other classes. They would hold the box up to someone to see if the

LED would light up and then declare if they were or were not an alien as the actors did in the movie, Men in Black. Finally a team noticed that the LED intensity changed when the box was close to a light switch. Did it have something to do with electricity? Someone noticed that it was also effected by the television. They were getting close. It was great watching fifteen students looking at a little black box and scratching their heads. Of course Fran lied to them about what it did and that just added to the fun.

The day of the oral presentations arrived. The principal, Dr. M, was invite to attend. Team 4 discovered that friction caused changes in the LED and the box could be used to see electrons. Had part of my goal of having students "see" electrons been realized? Team 1 decided that the box detected electricity in different forms such as AC and DC and could detect electricity in the walls around light switches. Team 2 tried the box with wooden blocks, balloons, rubber, carpet and light sockets and decided that insulators would not light up the LED. Team 3 discussed Coulombs Law in their presentation. Had they introduced the next unit for me? They also tried balloons and other objects. They had discovered that the box worked best when it was close to an object and should not be touching the object. They even had a nice poster describing their findings. Team 5 found out that it attracted static electricity. But, they presented a day after the other teams had completed their work and had an unfair advantage. The principal seemed to be impressed with the students reasoning ability and presentations.

After a week I asked for reflections on the project. One comment was: "I learned about electrostatics and the box showed us the differences in charges. "They could "see" charges. Did this indicate that it was a successful project? Another comment was: "This lab was quite a challenging one. I learned though, that this device detects electric fields and tells you the difference in charges near it by the way it reacts. I also learned that attempting to figure out what an unknown objet does is hard." A third student comment was: "This alien detector lab was helpful, because never knowing about static electricity, it was fun and exciting way to discover this area in physics." Another student said: "I didn't like this lab very much. I suppose I learned about electricity and things, but it was a confusing lab."

Was the project successful? I think it was. One group felt that they could "see" the charges and this was the main goal. In addition, the students had learned about static electricity before I introduced the topic in class and were thus ready to move into the study of electrostatics in greater depth. They also could practice oral presentations and connecting ideas in a meaningful manner. Some students thought that the lab was confusing. However, I think that they were probably the students that like to memorize material and want everything laid for them in a nice neat manner so that they do not have to think. The students that like to think and experience new concepts seemed to enjoy the project and got the most out of it.

Materials required: Charge detectors were built following the directions in the article by William J. Beaty entitled, Ridiculously Sensitive Charge Detector, available at http://www.amasci.com/emotor/chargdet.html.
Radio Shack parts needed: standard 9-V battery, battery connector (#270-325), MPF-102 N-channel Field Effect Transistor (#276-2062), Red Light Emitting Diode (LED) (#276-041), Dual General Purpose PC Board (#276-148), Project Enclosure (plastic, 4x2x1" -#270-1802), and Toggle Switch SPST (#275-612). Holes must be drilled in the box for the LED, the antenna and the switch.