Project: Renaissance in Science Education
Location: Riverview Gardens Schools, St. Louis
Author: Jack Wiegers

I. A SHORT DESCRIPTION OF THE UNIT'S ACTIVITIES AND LEARNING GOALS

The instructional unit is STC *Magnets and Motors*. A brief description of this unit is as follows:

> *Magnets and Motors* is a unit of 16 lessons about magnetism and electricity designed for 6th grade students. It mirrors the historical development of our understanding and use of magnetism, electricity, and electromagnetism. The unit progresses through these phenomena in the same order that people first learned about them. Students engage in activities involving magnets and compasses, electricity from batteries, then electromagnetism (electromagnets, motors, and generators).

The learning goals for Magnets and Motors are as follows:

Understandings

- Magnets attract and repel each other; this attracting and repelling can be used to cause motion.
- A compass can be constructed by suspending a magnet so that it is free to rotate.
- A compass will move in response to a magnet placed near it.
- An electric current in a wire produces magnetism; a coil of copper wire conducting an electric current becomes an electromagnet.
- A steel bolt placed inside a coil of wire conducting an electric current increases the strength of the electromagnet.
- A simple motor can be made from an electromagnet and a rotating armature.
- An electric current can be generated by placing a rotating coil of wire near a magnet.

Skills

- Observing, describing, and recording the results of experiments.
- Learning to plan and conduct experiments in which variables are controlled.
- Predicting and testing how changing a variable affects the outcome of an experiment.
- Interpreting the results of experiments to draw conclusions.
- Applying troubleshooting strategies to investigations with compasses, electromagnets, and motors.
- Reading and research to learn more about electricity and motors.
- Communicating results through writing, drawing and discussion.

Attitudes

- Developing an interest in experimenting with the technology of motors.
- Appreciating advances made in the use of magnets, electricity, and motors.
- Recognizing the important of validating results through repeated testing.

Note: While doing the activities in this module, the teachers used a science textbook on Electricity and Magnetism from the Prentice Hall Science Explorer series.

II. BACKGROUND INFORMATION ON: A. THE PEOPLE WHO PROVIDED THE PROFESSIONAL DEVELOPMENT AND B. THE TEACHERS

A. Background Information - the People Who Provided the Professional Development We (Ann P. McMahon and Jack Wiegers) asked the supplier, Carolina Biological, of this module for a recommendation for persons who had provided professional development for this module in other districts. The person who provided the brief professional development on this module has spent years as a classroom science teacher. Her background is in the physical sciences. In these last years, she has worked at the university level. She has taught in a university laboratory school and provided professional development.

B. Background Information - the teachers: 1. Why and How Teachers to be Observe were selected. 2. General Information about the Teachers Gathered in the Interviews and the Observations.

1. Selection of Teachers to Be Observed: The three teachers that we selected teach in the same building and they are the only teachers of science in the building. One question that we wanted to answer was: Were the students receiving the same set of experiences and coming to a common set of understandings and skills? This is an especially important question in the School District of Riverview Gardens because of the very high mobility rate between schools and between teachers within the same school. Ann P. McMahon, science coordinator, asked the teachers whether they would be willing to be observed and they readily agreed to be observed and interviewed before the observations.

2. General Information about the Teachers Gathered in the Interviews and in the Observations:
I would like to provide a brief “composition of place and persons.” The classrooms of these teachers were bright-- inviting color scheme, lighting, furniture (tables and desks), many posters. I found the posters interesting since most of the posters dealt with values, such as, respect, cooperation, importance of learning, the importance of service, and so forth.

The three teachers whom I observed modeled these values. In my interviews with them before my observations, one teacher (a former Peace Corps volunteer) gave voice to these values and stated how the values informed her teaching. I believe that all three teachers modeled these values.

In each classroom, there were about twenty-five students. The students were engaged (for the most part) and noisy. Teachers were clearly in control but expended lots of energy in keeping students focused. Teachers looked tired at the end of each day. I

spent one complete day in these classrooms, did nothing, but was exhausted at the end of the day.

III. EXPECTED CHALLENGES A. FOR TEACHERS WITHIN THE CLASSROOM AND B. FOR PROFESSIONALS DEVELOPMENT:

A. Challenges for Teachers: I expected the challenges to fall into four categories: (a) a practical challenge--building and keeping the equipment adjusted so that observations could be made, (b) a pedagogical challenge--structuring lessons that move students from observation to scientific understandings, (c) a science content challenge--understanding, at a deep level, elementary and middle school science, and (d) possibly a classroom management challenge.

Practical Challenge: In the later lessons of this unit, a major challenge is building and continually adjusting the equipment. In the lessons that I observed (Lesson 12 - Making a Motor T.G. p. 80, Lesson 13 Building a Spinning Coil Motor T.G. p. 88, and Lesson 15 How does a Motor Work T.G. p. 96), students had to adjust and keep adjusting five or six things — this is not a trivial task.

Pedagogical Challenge: Help teachers to understand: First, what are the questions that focus students' attention so that students make and describe important observations? Second what are the concepts formed from observations that both teachers and students can make together? What are other concepts, especially ones that describe invisible processes and that must be developed in other ways? Some concepts, such as, circuit, battery, conductor, and so forth, come from observations that teachers and students share. Other concepts, such as, voltage, electron, current, and so forth, are formed through analogies. Third, how these concepts can be used to develop models and major benchmarks.

Science Content Challenge: Help teachers to understand deeply elementary and middle school science. That is to say, help teachers to understand the great models and benchmarks in a way that they can trace back in their own knowledge the evidence both direct and indirect that supports these benchmarks.

B. Challenges for Providing Professional Development: The challenges for providing professional development come from the school community, the science teachers, and the materials.

The School Community: The two middle schools are experiencing difficulties in providing the conditions for learning that enable all students to achieve success; many of these difficulties come from factors not under the schools' control. To respond to these difficulties, the two middle schools and the high school have adopted a national program, First Things First. To start this program, the staffs are spending a large amount of time in planning and meetings. The school is undergoing major reorganization that includes starting a block schedule and moving sixth grade students

to the elementary schools. Thus, little time for professional development in science is available.

The Science Teachers: Over the last three years, we have offered resources (materials, material management, professional development, and so forth) to the middle school science teachers. Teachers questioned whether they would be supported. Teachers did not want to add more hours to their already busy schedule. They felt that they did not have time to look at new instructional units, such as STC materials. They stated that they need new textbooks that would be used as a resource, not the curriculum. In our judgment, a root issue was that teachers did not want to engage in a conversation that they perceived to be telling them what they had to do.

However, in mid-July of this year, because of the school reorganization, the middle school science teachers asked the science coordinator, Ann P. McMahon, to help them plan. The science teachers and the science coordinator agree on limited goals for curriculum and professional development. They agree to try some STC instructional units and that, on each of two units, they would spend a half day in professional development and on one unit they would spend a day.

The Materials: To make the best use of this limited time, we decided to bring in outside consultants who have extensive experience with the units. We recognized that, in the time provided, teachers were not going to gain deep knowledge and skills. We hoped that teachers would gain some comfort and confidence with the use of these materials since many middle school teachers stated that they did not feel comfortable teaching physical science.

IV. INFORMATION ON THE PROFESSIONAL DEVELOPMENT:

A. First Time Professional Development Experience: All three teachers participated in the same professional development session (4 hrs.) and this professional development was the first professional development provided to these middle school teachers. As mentioned above, the session was led by a consultant recommended by Carolina Biological, the provider of STC kits. The consultant had given this session many time to other groups. The session consisted of doing the activities (lessons) with helpful suggestions about organizing the materials and possible trouble spots.

The lessons in this unit are as follows: 1. Getting started, 2. What Can Magnets Do?, 3. How Can You Find Out What Magnets Can Do?, 4. Measuring Magnets, 5. Building a Compass, 6. Using a Compass: Which Way is Which?, 7. Creating Magnetism through Electricity, 8. Making Magnets with Electricity, 9. Planning an Experiment to Test the Strength of an Electromagnet, 10. Testing an Electromagnet, 11. Showing Other What You Have Learned, 12. Making a Motor, 13. Building a Spinning Coil Motor, 14. What Is Inside an Electric Motor?, 15. How Does a Motor Work?, 16. Generating Electricity

In my interview with each teacher, they gave the professional development very high marks and thought that it met their needs. They did not express any desire to know

what students and teachers who have worked with the materials think about the material nor the concepts and fundamental ideas that could and should be gained from the activities. They were appreciative of having the materials and an opportunity to work with the materials before having to use the materials with students. In short, they were very satisfied with the help that they were given.

B. Teacher Support: Each teacher has a complete set of materials that comes with the STC Magnets and Motors module. They have a few hours a week of teacher aide time for preparing materials. Sometimes the aide can be in the classroom when students are doing the activities. Although we were available for questions and were willing and anxious to form support groups, teachers judged that they did not have time for this. The three teachers did meet together and had discussions about the unit but the content of these discussions was largely confined to logistics.

C. Follow up Professional Development: Teachers have not yet completed this unit. In the interviews, they expressed a desire to meet and discuss lessons learned, successes achieved, and challenges remaining, but NOT during this school year.

D. Number Hours in a-c: There were four hours of professional development. Clearly this amount of time is insufficient though teachers judge it to be just right. Still, even this small amount of professional development represents a major step forward. It was a response to a request for professional development that came on very short notice. Three years ago, middle school science teachers were very resistant to professional development and thought they were being told what to do and, thus, not respected. They are now participating and many are seeing advantages to working together. There is clearly reason for hope.

V. INFORMATION ON CLASSROOM OBSERVATIONS

I did a brief pre- and post-interview and two observations (each 90 minutes in length) with each teacher. I observed one teacher on October 22 and all teachers on October 25 and two teachers on October 26.

In the beginning of all the classes, teachers and students spent time on opening questions. Most of the questions were drawn from the sections called Think and Wonder and Find Out for Yourself in the student activity book for Magnets and Motors. For example, from Lesson 13, teachers used the following questions: Imagine a motor that works even when you do not turn the switch on and off. How does it work? Where does the electricity go? However, some questions or assignments were drawn from the text. The questions or assignments from the text were of a very general character. For example, make a data table of appliances in your home, including lights, that use electricity.

Also, at the beginning of the classes, teachers and students talked about the upcoming lesson. In some classes, objectives were written on the board. (For example, demonstrate how to operate a small electric motor. Learn what is inside a small electric

motor.) In other classes, teachers and students looked at and read the student activity book.

In the classes that I observed, most of the time was spent in doing the activities. The teachers had different approaches to the activities and what they let students try to do, but all did a common set of activities. For example in one classroom, the teacher had made judgments about the difficulty of building and maintaining the equipment so she and the aide did some activities that the developers of the unit assigned to the students. Another teacher exactly followed the procedures laid out in the student activity book. The third teacher was between and closer to the first. All of the teachers said that they had used the text to read about the activities before doing the activities. I thought the teachers understood how the activities should be accomplished and were comfortable with doing the activities. Most students were engaged and excited when they got coils or compasses to spin. In the lessons that I observed (Lesson 12 - Making a Motor T.G. p. 80, Lesson 13 Building a Spinning Coil Motor T.G. p. 88, and Lesson 15 How does a Motor Work T.G. p. 96), students had to adjust and keep adjusting five or six things — this is not a trivial task. (If teachers are willing to meet and discuss this unit, a discussion on managing or improving the materials could be fruitful.)

In the classes that I observed, I did not observe time being spent on collecting and processing observations, which raises the question of whether the teachers understood the content of the module deeply and well. I would guess that the teachers did not. Teachers talked to me about not having a strong background in physical science. The professional development, as mentioned before, was very short and was directed to getting the teachers to know how to use the materials and to do the activities and not to understanding. I did not observe the teachers relating what was in the text on electricity and magnetism to what the students did in the activities. I left the observations thinking that, by and large, the students and the teachers were engaged in a very good set of activities but that only a limited number of the understandings, skills, and attitudes that the unit was designed to achieve were actually achieved.

VI. CONSISTENCY WITH THE PROJECT'S VISION

The subset of factors in the vision of Project RISE that address this question are: (a) All students must receive quality instruction and study a curriculum that engages them in a substantive conversation. In this conversation, students explain, hypothesize, and generalize. Students arrive at an understanding of both the benchmarks of science and the evidence that supports the benchmarks. Further students make connections between this substantive knowledge and either public problems or personal experiences. (b) All teachers live, breathe, and have their being in a professional community that understands and values inquiry learning and is characterized by reflective practice, sharing, and collaboration.

During the observations, the three teachers successfully engaged students in a set of activities that were coherent and were open to developing core concepts, fundamental understandings, and a model. However, they were not asking students to use their

senses to make, record, and share key observations. Nor did they ask students to make inferences or draw conclusions. During the observations, little questioning and closure were evident. Teachers were using quality materials but still did not have the pedagogical skills to nurture the type of learning congruent with the Project RISE vision factor (a) described above.

All three teachers were very enthusiastic about the professional development in which they had participated. They were delighted with the materials and help that they received in using them. They want to continue to meet so I would infer they want a community and are willing to devote time to develop it. If this professional development turns out to be the first step and much more comes, I believe the professional development was successful and in important ways meets the vision of the project. Necessary but not sufficient may be the right words here.

6. Next Time Professional Development: If the same amount of time (4 hrs.) is available, I would raise the question whether it is a good idea to do such limited professional development. Are the teachers left thinking that one of these very good units can be understood in four hours? Are teachers left thinking there is very little to be learned? . Many teachers' experience of professional development is a workshop of a few hours to a couple of days and consists of doing activities that may engage them but frequently do not result in understandings. None of the teachers in the middle years have had a professional development program that is based on a plan with a carefully articulated scope and sequence that cover several years of professional development. One way of stating the goal of such a professional development program would be that every middle school teacher would meet the standards described in the National Science Education Standards including the standards that describe the knowledge that high school graduate should have. In the School District of Riverview Gardens, the professional development program for elementary teachers rests on such a plan. So before we begin next year's professional development, my hope is that the middle school teachers will craft such a plan.

I believe that, if once again we are given the opportunity to meet and work with the teachers on this module, we and the teachers should start with the teachers' experience, especially with the use of the materials. From their experience, we should move to looking at the observations that can be made and how these observations lead to models to account for what is seen. From these activities, I would hope we and the teachers could teach ourselves about the nature of inquiry and induction.