LINKING SIXTH GRADE
SCIENCE EXPERIMENTS
TO THE
OHIO MODEL COMPETENCY BASED
SCIENCE PROGRAM

MASTER'S PROJECT

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by

James A. Browning, Jr.
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This project is dedicated with thanks to my family for all of their encouragement and support -- but especially to my wife, Kathy, my sons, Paul and Brian, and my parents.
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"The terms and circumstances of human existence can be expected to change radically during the next human life span. Science, mathematics, and technology will be at the center of that change—causing it, shaping it, responding to it. Therefore, they will be essential to the education of today’s children for tomorrow’s world." (American Association for the Advancement of Science (AAAS), 1993, p. XI)

This writing experience supports the idea that teaching science for the students and citizens of tomorrow’s world should be an exciting exercise in learning for both teacher and student. However, textbooks as they are presently constructed emphasize the end product (rote answers, memorization) and do not encourage creative thinking along scientific lines; e.g., what would happen if....

The Ohio Model Competency-Based Program was created in order to accomplish the mission of the State Board of Education; namely, "to prepare all students of all ages to meet, to the best of their abilities, the academic, social, cultural, civic and employment needs of the twenty-first
century, by creating learning communities that emphasize the lifelong skills and knowledge necessary to continue learning, communicate clearly, solve problems, use information and technology effectively, enjoy productive employment, appreciate aesthetics, and meet their obligations as citizens in a democracy." (Ohio Department of Education (ODE), 1994, p. 9) This model embraces five guiding principles as follows:

1. All students can learn.
2. Every learner possesses multiple intelligences.
3. Participation in a learning community fosters growth.
4. Diverse instructional strategies and environments increase learning.
5. Learning is a lifelong endeavor.

(ODE, 1994, p. 9)

In order to adopt the Ohio Model Competency-Based Program, all aspects of the educational system must be reformed. Significant changes need to be effected in a completely comprehensive way, encompassing all students and all subjects. This reform must interact with all aspects of the system, such as curriculum, teacher education, organization of instruction, assessment, materials and technology, and policy. This comprehensive approach will be significant and long-lasting, but it should be understood
that this changed approach will take time to yield desired results.

The Ohio Model Competency-Based Science Program offers the teacher and learner the opportunity to interact at a more personal level. In the past, the teacher was perceived as the ultimate authority figure, and little responsibility for making decisions was delegated to the learner.

"Reform must be comprehensive and long-term, if it is to be significant and lasting. It must center on all children, all grades, and all subjects. In addition, it must deal interactively with all aspects of the system—curriculum, teacher education, the organization of instruction, assessment, materials and technology, policy, and more. All of which takes time." (AAAS, 1993, p. XII)

Changing to the Ohio Model method of teaching and learning is expected to influence every Ohio classroom—every subject at every level—not only because of the change in approach, but also in the choice of textbooks. Hands-on science learning generates a higher level of involvement by the student and promotes creative problem solving.

Many teachers feel they do not have the resources or the training needed to effectively teach science to elementary school children. A handbook of simple science experiments, coded to the Ohio Model, is needed so that teachers may more effectively teach their students in the new way.
Statement of Purpose

"Benchmarks specifies thresholds rather than average or advanced performance. It describes levels of understanding and ability that all students are expected to reach on the way to becoming science-literate. A well-designed curriculum will provide students with the help and encouragement they need to meet those standards." (AAAS, 1993, p. XIII)

The four strands of the Ohio Model incorporate these benchmarks. Therefore, all Ohio school systems must be ready to incorporate the Ohio Model into its science curriculum as soon as possible. The lack of widespread information about the Ohio Model has been a hindrance to teachers. A simplified approach to linking the Ohio Model to classroom instruction represents a pressing need.

The writer has attempted to ease the transition from the teacher-oriented workplace setting to the student-oriented learning center. The workplace setting places the emphasis on structured learning; e.g., how to make a motor run. The learning setting releases the teacher from being merely a "director" to being a guide and facilitator. In this new setting, the teacher will have more time and opportunity to assess the level of learning of each student.

"Contrary to a popular notion that hands-on, activity-based science curricula lacked a potent academic content base, we
found that students ... actually outscored students in the more traditional classrooms--by as much as 34 percentile points." (Shymansky, 1982, p. 14)

Armed with this information, it is imperative that teachers in all schools move ahead to the learning setting system as quickly as possible. This handbook is an attempt to assist the teacher in adopting the Ohio Model and to recognize the advantages of this new approach.

Definition of Term "Instructional Objectives"

The Ohio Model lists these objectives which are made up of four components and are directed to a particular grade level. The four component strands are:

A) Scientific Inquiry - the desired technical skills and abilities;
B) Scientific Knowledge - the big ideas of science to be studied;
C) Conditions for Learning Science - the strategies and activities for learning; and
D) Applications for Science Learning - ideas for how learners may use their learning. (ODE, 1994, p. 15)
These four strands will be consolidated into one instructional objective on a specific topic. Incorporating these components, a teacher will insure that (a) it is appropriate to the grade level; (b) learners have been given appropriate background and the scientific ideas are progressive; and (c) the teacher works with the students, delegates some authority and responsibility for the outcome of the experiment to the learner by assigning roles to the students such as getter, starter, reader, reporter, recorder (FOSS, 93/94), and finally (d) the learner realizes that science literacy is essential to becoming a socially responsible person. Thinking skills are sharpened as experiences build one on another and flow into other disciplines such as reading and writing.

**Definition of Term "Performance Objectives"

Performance objectives are statements of what students know and can do as a result of the science instruction at that level.

The Ohio Model indicates three levels of performance objectives, which can be written as follows:
1. Knowledge/Skill

Given a graph of the motion of a toy, the learner will verbally describe the motion of the object with a high degree of accuracy.

2. Conceptual

The learner will demonstrate an understanding of the concept of inertia by accurately contrasting the motion of two vehicles with differing masses.

3. Application

Using common classroom materials, the learner will construct a vehicle to efficiently move a heavy object and accurately explain how it works. (ODE, 1994, p. 17)
Chapter II

REVIEW OF LITERATURE

This researcher feels that science cannot effectively be taught solely from a textbook. The best way for students to grasp what science is about is to actively participate in hands on science experiments. As stated by Jaus (1977), "The results of this study showed that not only did activity-oriented science instruction significantly improve children's attitude towards science, but their attitudes toward school were also significantly improved." (p. 26)

Most students are naturally curious about the world around them. "Discovery oriented science," explains Marilee Donivan (1993), "motivates children to question, experiment, and discover." She further reports that "as students ask questions, design experiments, observe and record data, and evaluate and draw conclusions, they exercise higher level thinking skills - just what we teachers want our students to do." (p. 29)

The elementary students of today will be our leaders of society in the twenty-first century. These students need the benefits of hands on science teaching so they will be able to meet the demands for scientific literacy in the future. Glass (1993) proclaims that, "The need for science education reform in this country is clear, and many
strategies are being proposed by professional educators and scientists alike." (p. 38) He further adds that there are four principles on which science curriculum should be based, the core of which is open-ended problem-solving activities. These four principles correlate to the four strands as listed in the Ohio Model.

Teachers should meet the needs of students by providing them with meaningful appropriate hands-on methodology. Kralina (1993) states that "Science is a verb, one of action, not one of existence. Therefore, a hands on approach to teaching science should be stressed, using physical manipulatives or experiments to aid the students' retention of concepts." (p. 33) These hands-on experiments will help lower the abstraction of some science concepts while helping to build students' self-esteem.

Leach (1993) says that by using science activities, "students are challenged to break out of more traditional thought patterns, and are given a chance to display creativity and gain a clear understanding of the problem." (p. 30) Tatina (1993) states "Whenever possible, biology teachers should avoid lectures and assigned readings and replace them with hands-on and minds on activities so that biology teaching more closely reflects the work of biologists." (p. 28)

With so much data showing support for a hands-on approach to teaching science, why has it not been
implemented in all elementary schools' curriculum? A survey conducted by Donivan (1991) netted these comments: "It takes too much time." "I'm afraid I'll get in over my head." "I don't have enough equipment." "I don't have enough funding." "It's noisy and confusing." "It's easier to keep teaching the way I always have - through the textbook." (p. 29)

Another informal survey by Rossman (1993) yielded more interesting facts. The Chicago elementary public school teachers devoted only about ten percent of their science teaching time using the hands-on approach even though all teachers agreed it was the best way to teach science.

The attitudes of teachers could be changed by conducting workshops based on the Ohio Model to help them be accomplished science teachers. Indeed a study by Gabel and Rubba (1979) discovered that workshops are one way to help teachers overcome their fear of teaching hands-on science. Significantly, this same study points out that it is a long term process; teachers' attitudes cannot be changed in a short period of time.

Hands-on science experiments do not have to be complicated or costly to be effective. On the contrary, at the elementary level, the simpler the experiment is to do, the more students understand the process and the end result. To extrapolate, the more students understand the process and the end result, the more the students will improve their
thinking and processing skills. The learner will take these improved skills with them into the community and apply them in other situations that require logic and analysis. This new Ohio Model approach better prepares the student to deal with the unknown factors of the community outside the classroom.
Chapter III

METHODOLOGY

Materials and Resources

This writer collected ideas from many different sources. Of particular importance was the local book store, Books & Company. There are many valuable reference books available for browsing, and these were used. The Ohio Model recognizes the need for improvement in the area of physical science, and reading about what other teachers have already done successfully is a good foundation on which to build.

The teachers' resource room should be used for storing materials needed for various projects and experiments. These materials can be used by educators as needed. Some examples of items that might be found in the teacher resource room are magnets, flashlights, batteries, voltmeter, microscopes, and balloons. Easy accessibility and clear cataloging of materials is important.

Another useful source is the local public library. Again, there is a plethora of material on science experiments, much of it directed toward hands-on physical science.

Personal experience is not to be ignored. Whatever the teacher has learned through experience can be introduced and
passed on to students in the form of self-development. Friends, neighbors, and the students themselves might also contribute useful information.

The State of Ohio has committed itself to support efforts to improve science knowledge at all levels of education. With this in mind, the writer has sought assistance from many sources. One program in particular is Partners in Education. For example, every Dayton City School may draw on this resource. The Dayton Board of Realtors is the Partner in Education for Ruskin Elementary School. The writer prepared a proposal and subsequently received $300 to purchase a voltmeter; Partners in Education provide $100 credit annually at Books & Company for each teacher in the school to use as necessary. Lab coats were also donated by Partners in Education.

In addition, students and their parents sometimes donate items used for science experiments. Parents should be encouraged to become involved in gathering materials and resources for the experiments. The students can then discuss the experiment and results with their parents, which increases the student’s pride and self-esteem, especially when the resources donated by the parents are used. This involves the learner on a more personal level, and it follows that the learner is a real stakeholder in the successful outcome of the science experiments.
Dayton Public Schools has provided one week paid training for the author, spent on life science and physical science (electricity). Student handbooks and classroom kits are provided also; the classroom kit is outstanding for its simplicity and usefulness. Various other workshops offered by Dayton City Schools are definitely worth attending, and should be considered by all teachers of science.

Other unexpected windfalls come from surplus stores, flea markets and garage sales. Science teachers can be on the lookout for materials that can be used in classroom experiments, such as magnets, wire, switches and sockets, and wool blankets.
CHAPTER IV

PHYSICAL SCIENCE EXPERIMENTS

Selecting Experiments

This writer chose a sampling of physical science experiments. Life science experiments work equally well. However, the writer selected favorite activities that were also suitable for the classroom and could be adapted to the collaborative method of student involvement per the Full-Option Science System (FOSS). These experiments and other similar activities can be used by any science teacher (Project STEP/Science Training Educational Program), and adapted to any elementary grade level.

The most important aspects of experiments are that the materials be readily available, relatively inexpensive, safe for use by students, and able to be easily understood. There should be results that can be assessed, and students should be able to feel they play an important role in the success of the experiment. Because occasionally an experiment will deliberately be undertaken to show failure (commonly expected result does not happen), there is a need to discuss and evaluate results at the end of each activity.

Teachers will organize and attend science workshops that engender close interaction between the teacher and
learner (see Slimeability Lesson Plan). The Ohio Model encourages this interaction, since both teacher and student benefit from this approach. Knowledge on the part of all participants is increased. The following six experiments illustrate how simple classroom activities can easily be geared to the Ohio Model.

**Series and Parallel**

The activity on Series and Parallel Circuits involves mathematics and expanded vocabulary, and gives the learner practical knowledge. Many students are particularly interested in hands-on science experiments that they can talk about at home, and demonstrate their knowledge. This gives the learner a sense of pride as well as involvement.

**Static Electricity**

Static electricity experiments are very simple and results are instantaneous. Materials are easy to obtain, and there is the advantage of a great deal of interaction among the participants. Knowing when to expect static electricity to occur is also something a learner can discuss with friends and family with a resultant sense of pride. This experiment frees the teacher almost completely, leaving the teacher to observe the learners and assess the results.
Conductivity

In keeping with the objectives of Project STEP, through continued use the teacher will become knowledgeable and comfortable with the Ohio Model. One useful experiment is the study of conductivity, which is the ability of electricity to move easily through matter. All students are familiar with this concept though they may not realize it is called conductivity. For this reason, it is an ideal activity for the teacher to use the collaborative team setting. Vocabulary is enhanced, and there is usefulness in learning which materials are conductors and which are insulators. The results are immediate, which is desirable at the elementary level.

The teacher will act as facilitator, and will guide the team through the activity. Some examples of conductivity/insulator experiments are discussed in the Lesson Plan Section.

How Current Flows

Building on information gained through previous experiments, the teacher will proceed to form a team of learners to demonstrate how current flows (negative to positive direction). This activity will stimulate creative thinking at the middle school level. All physical science
activates enhanced vocabulary, and this particular experiment will enable the student to gain very practical knowledge, while at the same time allowing the teacher to clear up misconceptions or even errors in thinking on the part of the learners. For example, there is only one way to make a flashlight work, but the students will probably try several variations before finding the right combination. The teacher can determine the level of student knowledge by observing and guiding. This experience can then be shared with other teachers, and can be a idea resource for other teachers.

**Magnetic Field**

This experiment is appropriate for any elementary school teacher and student. Simple horseshoe magnets that illustrate how magnets attract and repel are an important point of electricity. The usefulness of this knowledge will become evident in later experiments. A student is likely to find this experiment memorable, as it is a visual concrete experience.

The teacher will ask questions of the students, encouraging free thinking; e.g., what will happen if I (we) use a larger, stronger magnet, or a same-size magnet of a different material? (See Conductivity for more information.)
The student will share the knowledge gained from this experiment with friends and family, increasing his self-esteem.

This is a very simple, inexpensive experiment with many advantages for both student and teacher. Beyond the intellectual and emotional value, it is fun and interesting.

**Slimeability**

In the slimeability experiment, different glues give different results, which can be put on a simple bar graph. Again, the collaborative team approach works exceptionally well in this activity, freeing the teacher to evaluate each participant's understanding of the experiment. Mathematics (graph), vocabulary (borax powder), and process/product relationship are involved. In this and all the following experiments the teacher acts as a facilitator rather than the sole evaluator.
It is the intention of this writer to guide the elementary school teacher through the transition from the more authoritarian old-style teaching to the more participative style of the Ohio State Model. This writer has chosen several favorite tried-and-true experiments that encourage teamwork, increase science vocabulary, build self-esteem through knowledge, and at the same time free the teacher for more constructive work.

Expanding on the previously discussed definition of the four Ohio Model strands, "knowledge" is only one piece of the puzzle. The processing skills associated with the "inquiry" strand are expected to improve after adaptation to the Ohio Model, e.g., classifying, measuring, observing. The third strand, "Conditions for Learning Science," activities should be based on learner's cognitive levels, strengths and learning styles. The fourth strand, "Applications for Science Learning," shows that students "who can internalize the ability to correlate to and integrate science learning with the entire school experience, this ability becomes useful for the rest of their lives." (ODE, 1994, p.22) For this reason, the educator must design experiments that "are of interest to
the student, i.e., age-appropriate, real-life experiences that will fully develop scientific knowledge and problem-solving experiences that will fully develop scientific knowledge and problem-solving skills while making school science relevant and engaging (interesting) to learners." (ODE, 1994, p. 22)

The selected experiments/activities are geared to physical science at the sixth grade level but the methodology is equally applicable to all grade levels as well as the field of life science. This handbook is intended to serve as a guideline on how to make the old-style/Ohio Model teaching style transition as comfortable and simple as possible.

In this chapter, the writer has described six experiments that any teacher can either incorporate as they are or adapt to other fields of science. The teacher may elect to build progressively as the experiments continue, but the experiments may also be stand-alones. For example, if only a few experiments are selected, any of the six samples are appropriate for separate use. It is not necessary to follow a particular sequence, nor even to conduct the same experiment at the same time. One class could be investigating magnetic fields while another could be looking at conductivity. If the teacher wishes, he could discuss interactions of results in a forum setting of the various elementary school classes.
The reader will note that preceding each lesson plan are listed selections from each of the four strands from the Ohio State Model. Immediately following each of the Ohio Model strands is the rationale used as the basis for the selection of that particular strand for the experiment. Then, to keep all relevant information on each experiment together, the instructional and performance objectives for each experiment are stated at the end of each experiment. The writer has found that it is easier to absorb related information if it is grouped together in this way than it is to move from one chapter to another to find additional data. The Ohio Model encourages this type of simplicity, as it increases the level and scope of understanding on the part of both teachers and learners.

While it is a fact that all students can learn, they learn in varying degrees. "If the students themselves participate in scientific investigations that progressively approximate good science, then the picture they come away with will likely be reasonably accurate." (AAAS, 1993, p. 9) To state it another way, if the subject matter is presented in a participative and interesting way, the students are likely to learn more quickly. This is the "Aha!" factor, the pride that comes to the learner when he grasps a heretofore unknown idea. It is the responsibility of the teacher to offer this opportunity, and this handbook is presented as an aid for this important activity.
The teacher will ask the learners to suggest different ways (materials, quantities, etc.) to conduct the experiments. As the students become more involved, their pride in their own progress increases accordingly. This makes for a learning-community environment—the community being the school at the present time, evolving to the wider local and business community as the student grows and understands the value and practical application of learning. There is no cap on the time that is spent learning, as the students are continuously expanding their areas of knowledge and interest.

The writer has endeavored to understand these basic premises, and has created this handbook in the hopes that these experiments will help open the gates to unlimited creativity on the part of both learners and teachers.
Series and Parallel Circuits

• Ohio Model Strand/Scientific Inquiry (Grade Level Six, p. 39)
  Utilize appropriate units for counts and measures and keep track of them in computations performed by hand, calculator or computer.

• Writer’s Rationale/Scientific Inquiry
  Voltmeter gives the learners experience with a new measurement tool.

• Ohio Model Strand/Scientific Knowledge (Grade Level Six, p. 39)
  Investigate the limitations of individual components within technological, social, and ecological systems.

• Writer’s Rationale/Scientific Knowledge
  Understanding a simple series or parallel circuit is appropriate at sixth-grade level.

• Ohio Model Strand/Conditions for Learning Science (Grade Level Six, p. 39)
  Consider the perspectives of others in group investigations of rational phenomena.
• Writer's Rationale/Conditions for Learning Science
  Group interaction encourages learning by investigating and participating in series vs parallel circuit experiments. Development of this group investigative procedure can be applied to solving problems in future business and community settings.

• Ohio Model Strand/Application for Science Learning (Grade Level Six, p. 39)
  Make everyday scientific and technological decisions.

• Writer's Rationale/Application for Science Learning
  The experiments are exciting and fun; in addition, they give the learner useful application to real-life situations which they may quickly use (e.g., Christmas tree lights circuitry).

  Instructional Objective

The learners will work in pairs and investigate the limitations of series and parallel configurations, consider the perspectives of their partner and investigate everyday technological decisions by utilizing a voltmeter.
Performance Objective

The learners will be able to successfully build series and parallel circuits, and be able to explain the function of each.
A circuit can easily be demonstrated using a battery, light bulb, and a small piece of wire. (Knowledge) As you will remember from the previous lesson, as long as the circuit is complete, the bulb lights up. But what happens when another bulb is added? The illustration in Figure 1 will show one way another bulb may be added. This is an example of a simple series circuit. There is a problem, though. The two bulbs are each dimmer than just one bulb. Three bulbs are even dimmer. Why? (Inquiry)

![Series Circuit Diagram](image)

**Figure 1**
To find the answer to this, we need to use a volt ohm meter. Set the meter on DC 1.5 volts, and have one of the students check the output for just one bulb. It is 1.5 volts. However, when two bulbs are lit, (see Figure 1) the volt reading drops to .75 volts or 1/2 the original 1.5 voltage. Three bulbs test at .375 volts or 1/2 the second reading. Eventually, if enough bulbs were to be added, they would fail to work. Furthermore, try unscrewing one bulb, and the others also quit working. In the "Old Days," Christmas lights were all wired this way using a simple series circuit. When one light bulb failed, you really had no way of knowing which one it was without checking them all!

A solution to this problem is to wire the bulbs in a configuration known as parallel. Figure 2 shows a simple parallel circuit.

![Parallel Circuit Diagram](Figure 2)
Many bulbs may be added in this way, and all of them will be bright when lit. Test any bulb in this circuit with a voltmeter, and you will find that it tests at 1.5 volts no matter how far it is from the original source. The other advantage to this type of circuit is that if one or more bulbs are removed or if they simply burn out, the rest of the bulbs will stay lit. This is because in a parallel circuit, each bulb is wired on its own path; the electrical current is not shared. In a series circuit, each appliance that is added weakens the force of the current that they all receive; the electrical current is shared.

After the experiment, the students will discuss in a group setting (Conditions) the practical application of understanding the different uses of series and parallel circuits (Application). Another benefit occurs from the use of mathematics.
Static Electricity

- Ohio Model Strand/Scientific Inquiry (Grade Level Six, p. 39)
  Utilize caution and demonstrate care and concern for one’s self, classmates, equipment, specimens and environment when making observations and participating in group interactions.

- Writer’s Rationale/Scientific Inquiry
  The learner recognizes how to safely avoid or create static electricity (electric shock) with this experiment.

- Ohio Model Strand/Scientific Knowledge (Grade Level Six, p. 39)
  Investigate inferences about large objects, and systems made from observations of smaller objects, and systems.

- Writer’s Rationale/Scientific Knowledge
  The learner will understand that a change in the numbers of electrons in the atom creates static electricity.

- Ohio Model Strand/Conditions for Learning Science (Grade Level Six, p. 39)
  Performing investigations in a community environment (e.g., natural, altered, and built).
• Writer’s Rationale/Conditions for Learning Science
  Students will have enough time for the experiment as static electricity occurs almost immediately. Communication of results within the group is easily demonstrated, and the balloons and wool are readily available.

• Ohio Model Strand/Applications for Science Learning
  (Grade Level Six, p. 39)
  Making everyday scientific and technological decisions.

• Writer’s Rationale/Applications for Science Learning
  After the experiment, the learner will know how to avoid static electricity shocks. This helps the student to decide what is unsafe in this area.

  **Instructional Objective**

  Learners, working in pairs, will safely investigate the phenomenon of static electricity in everyday life and make observations and record them to lead to making predictions.

  **Performance Objective**

  The student will be able to demonstrate one example each of positive and negative charges.
Everyone has experienced static electricity. Walk across a carpet and touch the doorknob; you get a shock. Rub a balloon on your hair or sweater; it will stick to the wall. Dry your clothes in a dryer without a fabric softener, and they will all stick together. What is static electricity? How is it caused? (Inquiry)

To understand, you first need to know about atoms. (Knowledge) Atoms are tiny units that make up all matter. An atom consists of three parts, the proton, the neutron, and the electron. In the center (nucleus) of the atom are protons which carry a positive charge and neutrons which are neutral; that is, they carry no charge. Electrons, which have a negative charge, spin around the nucleus of the atom. As long as there are an equal number of electrons and protons, there is no static electricity. However, if the atom should lose electrons (or if it should gain electrons), then the resulting imbalance of electrons causes the atom to become electrically charged. This is static electricity. (Knowledge)

What causes this to happen? Some atoms hold their electrons strong, while others hold them weak. When two materials of opposite binding strengths are rubbed together,
electrons "jump" from the weaker substance to the stronger one. The stronger substance now has an imbalance of too many electrons, and has become negatively charged. The weak substance has lost electrons and now has more protons than electrons, which causes it to carry a positive charge. The rules of static electricity are: Opposite charges attract, and like charges repel.

To prove this, we will elaborate on the balloon example given on the previous page. Working in pairs, have the students rub an inflated balloon with a piece of wool. The wool sheds some of its electrons easily. These are passed on to the balloon, which is now negatively charged. Place the balloon against a wall. The balloon will stick to the wall until enough electrons are lost to neutralize the charge. When this happens, the balloon will fall. (Conditions)

Now have the pair of learners rub two balloons with wool. The balloons will both pick up some electrons and become negatively charged. Now have the teams try to put the two balloons together. The resulting like charges in the two balloons will cause them to repel each other. They will be forced apart. (Conditions)

After this experiment, the students will understand how to avoid instances of static electricity. (Application)

There are many other simple experiments that can be done to demonstrate the phenomena of static electricity.
Conductivity

- Ohio Model Strand/Scientific Inquiry (Grade Level Six, p. 40)
  Select and use math tools such as numerical manipulation (e.g., whole, fractions, decimal equivalents), geometric figures (e.g., circles, rectangles, triangles, eclipses, planes, spheres, rectangular solids), and simple tables, graphs and representational charts (e.g., simple line graphs, pie and bar charts, pictographs) to measure, count, order, sort, identify, describe, label and communicate information from observations.

- Writer’s Rationale/Scientific Inquiry
  The learners will share observations about whether certain materials are conductors or insulators. Results are recorded on a table.

- Ohio Model Strand/Scientific Knowledge (Grade Level Six, p. 40)
  Investigate the reversibility of phenomena and events in terms relative to time and space (e.g., changes of phase, collisions, rechargeable batteries).
• **Writer’s Rationale/Scientific Knowledge**

The learner will investigate the conductive or insulating property of the material being tested by using a voltmeter.

• **Ohio Model Strand/Conditions for Learning Science (Grade Level Six, p. 39)**

Asking for evidence that supports or refutes explanations.

• **Writer’s Rationale/Conditions for Learning Science**

The learner is encouraged to participate in the experiment by bringing other materials and sharing his findings with other students. The voltmeter gives the results with a simple yes or no.

• **Ohio Model Strand/Application for Science Learning (Grade Level Six, p. 39)**

Gaining insight into his/her own situation in light of the historical background of important inventions and technologies.

• **Writer’s Rationale/Application for Science Learning**

The learner will expand his understanding of the use of the voltmeter with this experiment. He will increase his general knowledge of safety; e.g., make sure a plug is non-conductive before inserting it into a socket.
Instructional Objective

The learners will work in pairs and compile a table of conductors and non-conductors by observing a simple electrical circuit interrupted by evidence that supports or refutes a prediction concerning the reversibility of phenomena (e.g. lightning) and gain insight into the historical background of important inventions and technologies.

Performance Objective

The student will be able to build a test unit and use it to demonstrate whether a material is a conductor or an insulator.
Conductivity

Conductivity is the ability of electricity to move easily through matter or a substance. Any material that allows electricity to pass through it is called a conductor. Consequently, any material not allowing electricity to pass through it is called an insulator.

Using a simple circuit consisting of a light bulb, battery and wire, we will use a voltmeter to test various materials to discover whether they are conductors or insulators. (Knowledge) The results will be recorded on a simple table. (Inquiry) Remember to make a prediction before testing each material. The first list of materials tested will be assigned by the teacher. After completing the testing of these, the students will add to the list with items of their own choice. (Conditions)

Each material to be tested is placed between the bulb and battery. If the bulb lights up, this material is a conductor. If the bulb fails to light up, the material is an insulator.

The materials provided by the teacher should include zinc, aluminum, rubber, wood, glass, copper strips, etc. Try to think of materials that the students won’t think of themselves.
Questions should be asked, e.g., "How are some of the conductors alike?" (All metals are conductors.) "What good are insulators?" (They protect us from being shocked.) (Application) "Are some conductors better than others?"

After completing the tests, the materials should be classified either as a conductor or an insulator.

Following this series of experiments, the learner will have a better understanding of what materials are conductive and which are not, resulting in a greater level of personal safety; the learner will also be able to caution others when an unsafe condition is likely to occur. (Application)
How Current Flows

• Ohio Model Strand/Scientific Inquiry (Grade Level Six, p. 39)
  Design and conduct a range of investigations (e.g., observations of objects and events, controlled experiments) associated with everyday experience.

• Writer’s Rationale/Scientific Inquiry
  The learner will use a flashlight to discover what is necessary to produce a flow of current. This hands-on, minds-on approach will make it easy for them to grasp the idea of negative and positive charges.

• Ohio Model Strand/Scientific Knowledge (Grade Level Six, p. 39)
  Investigate various quantitative representations of rates of change and duration of phenomena.

• Writer’s Rationale/Scientific Knowledge
  The learner will learn the function of the various components of the flashlight, and their interaction to construct a workable flashlight. The strength and/or durability of the light emitted can be changed by varying the components (general purpose vs alkaline batteries, etc.). These variations and their results will be recorded on a single table, appropriate for elementary grade students.
Ohio Model Strand/Conditions for Learning Science (Grade Level Six, p. 39)

Critiquing presentations that utilize propaganda techniques (e.g., irrelevant motivators, half-truths, generalizations).

Writer's Rationale/Conditions for Learning Science

The student will investigate the market strategy that states krypton bulbs are much brighter and safer than standard flashlight bulbs. The krypton bulb is not much brighter, at twice the cost of the standard bulb. The advertising focuses, however, on safety as a fear factor.

Ohio Model Strand/Application for Science Learning (Grade Level Six, p. 39)

Evaluating and challenging where appropriate, the claims made in consumer product advertisements.

Writer's Rationale/Application for Science Learning

The learner will challenge the claims of propaganda such as the Energizer bunny - is alkaline a better buy, penny for penny, than a general purpose battery? This is useful knowledge in making consumer decisions.
Instructional Objective

Using flashlights, the learner will investigate what direction current flows as well as critique propaganda techniques used by manufacturers of dry cell batteries and evaluate the claims made in consumer product advertisements by using different brands of dry cells to check the duration of each.

Performance Objective

The student will describe how current flows by explaining the function and inter-relatedness of each component part of a flashlight.
Teacher Background/Lesson Plan

How Current Flows

After teaching students how to complete simple circuits, it is important for them to know about the direction that current flows. Electrons always move in one direction, negative to positive. A good way to demonstrate this is with a flashlight.

Each student will be given a flashlight and told that they are to take it apart and reassemble it. (Inquiry) The two dry cell batteries that are provided are to be placed back into the flashlight every way possible. Negative end to negative end, positive end to negative end, etc. The students are to make a prediction about whether or not the flashlight will work prior to each attempt at reassembling it. Results are recorded on a single table. (Knowledge) They will soon discover that there is only one way to make the flashlight work. The batteries must be stacked negative side down, and positive side up. With any other configuration, the bulb will not light.

At this point, pose the question "Can anyone explain how a flashlight works?" A few steps will probably be left out, but most students will be able to explain that the bulb gets power from the end of the dry cell touching the end of the bulb. Since the end of the dry cell battery touching
the end of the bulb is the positive end, this is an incorrect answer. A demonstration will be needed to fully explain the correct answer.

Using a plastic flashlight that has been partially cut away to expose the inner parts, explain to the students that a flashlight is also a simple series circuit. The end of the bulb contacts the positive end of the top dry cell battery. The batteries are stacked negative side down, with the negative end of the bottom battery contacting a spring which is also in contact with a strip of metal. The metal strip makes contact with the switch. When the switch is moved into the "on" position, the last strip of metal that contacts the side of the bulb completes the circuit. This allows the electrons to flow back into the dry cell battery through the positive end. Not all of the electrons flow back into the dry cell of course, some of them escape into the air. This is one reason that batteries do not last forever.

Now change from a regular bulb to a krypton bulb. How much brighter does the krypton bulb appear to be? What is the cost difference between the two types? Does the price difference appear to be justified? (Conditions) Is the personal safety and feeling of security that comes from using a longer lasting or brighter bulb worth the difference in price? When is this justified; ask the learner to cite instances. (Application)
Ask your students why they think that it is important to know about how current flows. Some answers might be to allow people to do simple wiring in their house, or to help in repairing small motors, etc.
Magnetic Field

• Ohio Model Strand/Scientific Inquiry (Grade Level Six, p. 40)
  Formulate explanations and inferences and make decisions on verifiable data.

• Writer’s Rationale/Scientific Inquiry
  The learner will use magnets to demonstrate the properties of attracting and repelling. Results are immediately obvious, sometimes visible and sometimes invisible, and the explanations are simple. Inferences (conclusions) are drawn from the results of these experiments; e.g., a larger magnet of the same composition will have greater magnetic attraction.

• Ohio Model Strand/Scientific Knowledge (Grade Level Six, p. 39)
  Investigate and make inferences from collections of magnets.

• Writer’s Rationale/Scientific Knowledge
  The learner will investigate the strength of the magnetic field created by varying the size and composition of the magnets.
Ohio Model Strand/Conditions for Learning Science (Grade Level Six, p. 38)

Participating in the selection of topics and themes for class investigation.

Writer's Rationale/Conditions for Learning Science

The learner will participate in team experiments that show how to make an invisible magnetic field a visible magnetic field. Findings are shared among the teams.

Ohio Model Strand/Application for Science Learning (Grade Level Six, p. 38)

Learning, performing, and explaining illusions, from a scientific point of view.

Writer's Rationale/Application for Science Learning

The learner will be able to build self-esteem by performing the illusionary "visible/invisible" activity; which is explained in the Lesson Plan. On a more practical level, the learner will understand the phrase "Opposites Attract" and will become more knowledgeable in the vocabulary of electricity.
Instructional Objective

The learners will investigate the phenomena of the magnetic field and formulate explanations and inferences by performing and explaining simple magic tricks from a scientific point of view.

Performance Objective

The learners will be able to illustrate and explain a magnetic field.
This writer has some very powerful horseshoe magnets. These will be passed out to the students so that they may experiment with them. (Inquiry) While the students are busy "discovering," the teacher, building on the students' enthusiasm, begins the discussion. "Hold one magnet in your hand and try to make the ends of another magnet touch it. What happens?" (Some will attract and some will repel.) "Turn the other magnet around, and see what happens." Just the opposite will happen.

The magnets have an invisible force that we can feel, but cannot see. When the poles are the same, the magnets are difficult to touch together. When the poles are opposite, the magnets grab together.

Now using a bar magnet, iron filings, and a piece of plain white paper, we can make the "invisible" become the "visible." (Be sure to wrap cellophane around the bar magnet first. It makes for easier cleanup.) One student will hold the bar magnet steady while another student holds the paper keeping it a short distance from the bar magnet and keeping it taut. Sprinkle iron filings onto the paper. The student holding the paper should jiggle it a little. The magnetic field will dramatically begin to appear. This
may take a few tries to be completely successful. (Knowledge)

The teacher needs to keep a running dialogue with students describing what is happening. The two distinct forces, the north and south poles, become clearly visible. Have the students draw and label the magnetic field. Place two bar magnets south to south (or north to north) and almost touching each other, and see what it looks like. Then try this again using opposite poles nearly touching. Magnets lend themselves to exciting activities, both for student and teacher. (Conditions)

On a practical level, the learner will benefit by expanding his vocabulary, building self-esteem by performing the visible/invisible experiment for friends and family, and will know what the phrase "opposites attract" means, which is a phrase one hears many times during a lifetime. (Application)
Slime-Slimeability

- Ohio Model Strand/Scientific Inquiry (Grade Level Six, p. 38)
  Share findings and offer explanations for inconsistencies, limitations, and variability in recorded observations from similar investigations carried out at different times in different places, and using different techniques.

- Writer's Rationale/Scientific Inquiry
  The learner will measure and identify the ingredients needed to make the polymer slime. This experiment will require little or no encouragement on the teacher's part, as students usually enjoy this activity very much.

- Ohio Model Strand/Scientific Knowledge (Grade Level Six, p. 39)
  Investigate different versions of historical events in science (e.g., Thomas Edison and the light bulb).

- Writer's Rationale/Scientific Knowledge
  The learner will understand that even Thomas Edison had to experiment many times before he found the right filament for his light bulb. Along these same lines, the learner will find that one glue yields the best
results. The trial and error method is the same for slime as for the filament for Edison’s light bulb.

- Ohio Model Strand/Conditions for Learning Science (Grade Level Six, p. 38)
  Repeating learner-designed experiments several times to improve the reliability of results through improved experimental design.

- Writer’s Rationale/Conditions for Learning Science
  The learner will work in teams and vary the amount and brand of the ingredients, recording each variant, to conclude which combination is best. Each team will utilize a different variable.

- Ohio Model Strand/Application for Science Learning (Grade Level Six, p. 39)
  Follow step-by-step instructions, recipe, and sketches.

- Writer’s Rationale/Application for Science Learning
  Each team will present its conclusion as to the best combination of ingredients. The other teams will listen and all teams will make one final recommendation about the most slimeable slime.
**Instructional Objective**

The learner will follow step-by-step instructions to make the polymer slime and repeat the experiment several times changing only one variable at a time to improve reliability of the results much in the same way other historical events in science have been accomplished and will share findings and offer explanations for inconsistencies or variability in their findings.

**Performance Objective**

The learner will be able to mix the appropriate solutions and make a polymer (slime).
Today we will be making slime which is a polymer. A good way to introduce this lesson is to have examples of polymers to share with students. Examples would be most brands of car wax, silly putty, and a sample of slime. Polymers are cross-linking molecules. One way to get this concept across to your students is to have all of them stand and form a circle linking arms at the elbow. Have them all walk towards the center of the circle and then back out again without unlinking their arms. Now pull out the sample of slime and demonstrate stretching it out in different directions. This is all the students need to get motivated to make their own.

The materials you will need are borax powder, Elmer’s glue, water, food coloring (optional), cups, stir sticks, and ziploc bags (optional, but allows the students to take their slime home). Start with two solutions that we will call solution A and solution B. Solution A consists of equal parts of glue and water. Solution B consists of 1/4 cup borax mixed in 1 quart of water. This will not dissolve completely, and you may add food coloring if desired. To make the slime, mix equal parts of the two solutions
together. (Inquiry) Cross-linking occurs almost immediately, and the polymer slime is formed. Mix gently with a stir stick, and pour off any excess water. After you have demonstrated the process for the students, you can now have them each make some of their own. This is guaranteed to be a success!

"If more than one variable changes at the same time in an experiment, the outcome of the experiment may not be clearly attributed to any one of the variables." (AAAS, 1993, p. 12) To introduce variables, the teacher will change only the amount of ingredients, or brand of glue. Is the experiment just as successful as the original one? (It might be.) Have the students discuss the results, and conclude why not. (Knowledge) Trial and error is part of almost every successful finding, and slime is no exception.

Each team will introduce a different variable and will record the results. (Conditions) At the end of all the experiments, the team will make a final recommendation on which combination produces the most slimeable slime. (Application)
Chapter VI

SUMMARY AND RECOMMENDATIONS

Summary

The more things change, the more they remain the same. The learning environment is rapidly changing. It is the writer’s experience that increased student participation has a positive effect on the desire of the student to learn. However, this changing environment underlines the primary goal of the teacher; i.e., to offer the best possible education to his students.

The Ohio Model Competency-Based Science Program will promote changes in the learning environment from the authoritative teacher/student style to the participative team-oriented setting. The goal of the participative setting is to take the student beyond simply learning by rote to the realm of actively pursuing knowledge because knowledge itself becomes desirable in the student’s eyes. When the learner wants to learn, it is more exciting for the teacher to teach.

The focus of this handbook is to help direct the energies of the teacher to shift comfortably from the old style of teaching to the new Ohio Model style. Every idea contained in this writing can be adapted to other levels of
learning and other disciplines; e.g., mathematics, history, and social studies. The ideas of team learning, shared responsibilities for activities and group evaluation of results are similar to the methodology of conducting hands-on science experiments.

This writer recognizes that there might be a reluctance on the part of the academic community to shift to using the Ohio Model. However, the writer feels that this reluctance is due to uncertainty regarding just how to go about making the transition. Certainly every educator feels more fulfilled when he knows his students are learning.

The next section deals with recommendations on how to achieve this goal.
Recommendations

The writer has listed six physical science experiments that are appropriate to the sixth grade level. Once the unit was selected (in this case, electricity), the author wrote a lesson plan and then coded it to the Ohio Model. This can be done in reverse with equal results, if the educator is more comfortable selecting strands from the Ohio Model and then coding the lesson plan to the model.

As the educator becomes more familiar with the Ohio Model format, he will find that he is automatically incorporating each of the four strands into his lesson plan. For example, the Scientific Inquiry strand is how we find out information from an experiment.

The Scientific Knowledge strand keeps the experiment at the appropriate level by reminding the teacher that the activity must be something that the learner has the background to explore and investigate. The educator should make sure the students have the desired technical skills and abilities to conduct the experiment and evaluate the results.

The Conditions for Learning Science strand requires that the educator allocates enough time for the students to participate in a variety of different ways to do each activity. Group interaction is important in this Ohio Model
strand, as teamwork is required all through life. A student could be the recorder one time and the reader the next time.

Lastly, the Application for Science Learning strand encourages the learner to be able to apply the knowledge gained from the experiment to everyday life, expanding into his home and neighborhood. This includes the less tangible but very important aspects of increased self-esteem, the feeling of power that comes with a greater level of confidence, and most importantly, a desire to learn more about everything. This desire takes the learner beyond the classroom and make him more observant of and perceptive to outside environmental factors such as television advertising as it relates to the experiment in question.

The sequence of the experiments is interchangeable; the slimeability experiment could be first, last, or in between. If the teacher feels that the students need motivation to participate in hands-on experiments, then probably the slimeability, or a similar fun activity should be planned first. The methodology, however, is the same for each experiment, and is as follows:

1. Announce the experiment to the class about one week before the event. Describe the purpose of the activity and ask for student questions. (Scientific Inquiry)

2. Make a list of all materials that will be needed. Ask students for participation in compiling the list. This
will help the teacher assess the level of Scientific Knowledge of the group as a whole.

3. Investigate all resources to determine what materials are on hand, what may be donated by students, and what needs to be bought. Send a note home with the students asking for assistance. These experiments carry a minimal cost, but involvement on the part of the learner is important.

4. After materials are gathered, create teams. The teacher should make sure each participant is in a win-win situation, where even if the experiment fails, the student has learned from the activity and can share that with the rest of the class. The team might critique a TV advertising campaign or a written ad related to the topic -- concluding whether or not there was "truth in advertising." This brings in the Conditions of Learning Science strand from the Ohio Model.

5. In some experiments, such as slimeability, the learners should keep journals or logs describing the results obtained when an ingredient or quantity of an ingredient is changed. This also serves as a guideline for the teacher, as it offers the opportunity to assess the learner’s attitude and grasp of the reason for the experiment. Any part of the experiment that brings on frustration by the student should be carefully noted by the teacher, and used for future guidance.
6. Lastly, the Application for Science Learning ties up all the loose ends. If the student has been wondering "what does this have to do with my life?" then the educator now is presented with the opportunity to fulfill the mutual goal of better teaching and better learning. Physical Science especially has practical application even if the result is simply to make life at the sixth grade level more exciting. However, a more important benefit to the science-literate student lies in the area of employment opportunities. "Scientists are employed by colleges and universities, business and industry, hospitals, and many government agencies. Their places of work include offices, classrooms, laboratories, farms, factories, and natural field settings ranging from space to the ocean floor." (AAAS, 1993, p. 17)

Every teacher has the ability and even the responsibility to code lesson plans to the Ohio Model. It requires some changes in teaching methods, but these changes are easily accomplished. The Ohio Model was adopted to benefit the learner in several ways. These include improving processing skills, increasing organizational skills, encouraging curiosity by inviting questions that are cooperatively answered, and assimilating the knowledge acquired into his everyday life.

The learner will carry this science knowledge with him into the community. This increased awareness of the
importance of science literacy will greatly benefit the community. As a nation, we can no longer afford to graduate students who are not trained to think, ask questions, process information, and come to conclusions. We must provide citizens who will be world leaders in science and technology, and this begins in the classrooms with the teachers.

Today's teachers are continually working toward self-development in order to become better educators. The Ohio Model Competency Based Science Program offers a road map that can help us arrive at this destination.


