

SCIENCE MODULE

8th Grade

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TEACHING 8TH GRADE SCIENCE



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Using the Science Module

Objective

The materials in this book are designed to be used in a course for eighth grade science teachers. The selected activities have been used with eighth graders in the classroom but may not be appropriate for all classrooms. Teachers should follow local school district guidelines regarding the use of specific curriculum in the classroom. A variety of instructional strategies are used across the curriculum that will help the struggling eighth grade teacher successfully blend content and pedagogy which is requisite to mastering both the art and science of teaching.

The materials in this book are NOT designed to be used as a substitute for district curriculum. Some of these materials are classroom ready; other materials may require adaptation in order to use them in the 8th grade classroom. These materials address each of the 14 eighth grade science TEKS utilizing a constructivist teaching model. However, these materials represent a 3 hour college level course, and it is expected that each classroom teacher would add activities and content materials in order to create a year-long curriculum which meets school district requirements.

The purpose of the *Science Module: 8th Grade* is to:

1. build the teacher's science content knowledge;
2. strengthen the teacher's pedagogical skills;
3. help preservice teachers pass the TExES PPR exam for certification; and
4. increase student achievement on state exam.

Chapter Layout

Chapters 2-5 are stand alone chapters reflecting the 8th grade science TAKS objectives respectively. Each chapter is laid out using a similar format. Chapters are subdivided by individual TEKS or groups of TEKS. The subdivided chapters include materials that focus on the learning the knowledge and skills identified in the TEKS. TAKS Objective 1, which deals with science process skills, is not a stand alone chapter, but rather science process skills are distributed within the lessons contained in Chapters 2-5. Each of the TAKS Objectives is shown below:

TAKS Objective 1 – The student will demonstrate an understanding of the nature of science.

TAKS Objective 2 – The student will demonstrate an understanding of living systems and the environment.

TAKS Objective 3 – The student will demonstrate an understanding of the structures and properties of matter.

TAKS Objective 4 – The student will demonstrate an understanding of motion, forces, and energy.

TAKS Objective 5 – The student will demonstrate an understanding of Earth and space systems.

The first two-page spread of each TEKS lesson reflects the chapter's focus and objectives. The TAKS objective is introduced and is followed by the individual TEKS as stated in Texas state law. Next, the Overview section reflects the overall focus or rationale of what is to be accomplished or learned in the chapter. The overview section is followed by an explanation of the Instruction Strategies used in the lesson to build science content knowledge. Finally, the Objectives section lists the learning objectives highlighted in the chapter.

The second two-page spread section focuses on teacher background material and is titled *For Teacher's Eyes Only*. The content material is not intended to replace college science course material. Rather, it is provided to supplement the 8th grade text material and give the teacher an insight and understanding beyond the 8th grade level. This section is written in language focused on addressing the specific content knowledge required by a particular TEKS in an effort to deepen conceptual understanding for the middle school teacher who is weak in biology, chemistry, physics, or Earth science content knowledge.

After the *For Teacher's Eyes Only* section there is a section addressing 8th grade students beliefs and prior knowledge of science. This section begins with Misconceptions. Each misconception is broken into three parts: *naive concept*, *science concept*, and *rebuild concept*. The *naive concept* identifies misconceptions about science. The *science concept* presents current scientific thinking, and *rebuild concept* provides a strategy for dispelling and rebuilding the misconception.

The section titled, *Student's Prior Knowledge* includes 6th and 7th grade TEKS that are vertically aligned with the 8th grade TEKS discussed. Specific recommendations to address student prior knowledge are also included.

The next section displays the lesson outlined using the 5 E Model (described in this chapter under the 5 E Model). Activities, explanations, and assessment strategies are listed that address a constructivist approach to learning the particular TEKS. As new teachers often skip or gloss over explanation and evaluation, this model provides a paradigm that showcases each part of the lesson cycle. At least one activity should be used from each of the E's: Engage, Explore, Explain, Elaborate, and Evaluate.

Black-Line Masters are included at the end of each 5 E lesson series. The materials included here provide the course trainer with clean reproducible pages for copying to use with teachers in the class activities.

Constructivism

When Russia put the first satellite in space in 1957, a new direction in education was put into place to investigate methods to improve the learning process. One such idea, discovery learning was suggested by Jerome Brunner. Brunner proposed that students actively engage in problem solving to find a solution to a problem. The student could do this independently or by participating in a group. For example, students better understand how electricity works when given the opportunity to manipulate a battery, a small flashlight bulb, and an insulated wire with exposed tips. The student explores various methods that will cause the bulb to light up. In this way, meaningful learning occurs through a personal discovery process. However, everything cannot be learned via discovery, as this is sometimes too inefficient or expensive a process.

The role of constructivism in the learning process cannot be considered without attention to the many variables that influence how an individual constructs their knowledge. The following table describes some of the variables that affect the way learners construct their knowledge.

What does the student already know?	How do the learner's age, gender, and culture influence the learning process?
What skills does the student currently possess?	Will the student consider new information worthy of their attention?
To what extent do the ideas of others influence the construction of an individual's knowledge?	Is the student likely to form misconceptions by incorrectly incorporating new information into their knowledge base?

There exist two lenses through which constructivism may be viewed. One lens is referred to as cognitive constructivism and is based on the work of Jean Piaget. This view emphasizes cognitive processes in the acquisition of new information. Based on the ability of the student, new information can be assimilated into existing schemata and result in the development of new schemata. The second view, social constructivism holds that learning occurs when individuals are introduced to new information and given the opportunity to engage in social discourse to create meaning. Social constructivists call this process "negotiating meaning."

What Are Conditions That Nurture Constructivism?

There are a number of conditions that will nurture constructivism in the classroom.

Cognitive Apprenticeship - An apprenticeship between the student and the teacher. The teacher models the process of learning and gradually transitions the process to the student. Hints, questions, and suggestions may be used to scaffold the learning process.

Real problems in real settings - A student uses their knowledge of algebra to determine how long an area will be contaminated with radioactive waste.

Multiple perspectives - The problems one encounters in life seldom have a single cause and effect. Discussing a problem with others provides the opportunity to test our plan against the thoughts of others and to discover other solutions we may not have arrived at on our own.

There are limitations to using constructivism. Because of the interaction between the learner and the learning environment, a detailed lesson plan is not possible. A teacher must be able to think on their feet and move in a new direction at any moment. Also, the best efforts of a teacher will still leave some students with a different outcome from the lesson than was planned. Finally, constructivism is only one approach to teaching. For example, sometimes memorization of facts is essential. One cannot continually construct the multiplication tables to solve problems. At some point the multiplication tables must be committed to memory.

Learning Activities:

Visit the following website: <http://www.miamisci.org/ph/lpintro5e.html>

List and describe the 5 E's of constructivism. Based on the information you read, outline a lesson using the 5 E model of instruction.

Visit the following website: <http://chd.gse.gmu.edu/immersion/knowledgebase/>

Compare and contrast constructivistic and behaviorist learning characteristics. Which approach to teaching are you the most philosophically aligned with? Why?

Visit the following web site: teachers.ash.org.au/teachereduc/indexTE.html

Use the name, "Piaget" in the search function to locate the information on Piaget. Identify and discuss the implications of Piaget's theory as it applies to constructivism.

For more information about constructivism, visit the following websites:

http://www.constructivism123.com/What_Is/What_is_constructivism.htm

<http://www.funderstanding.com/constructivism.cfm>

<http://www.artsined.com/teachingarts/Pedag/Constructivist.html>

<http://www.artsined.com/teachingarts/Pedag/Dewey.html>

<http://www.sedl.org/scimath/compass/v01n03/1.html>

The 5 E Model

The 5 E Model is based upon the constructivist approach. The 5 E's are

Engage – The learner is introduced to a new experience and must draw from prior experiences to make sense of the engage activity. For example, the teacher uses a question, demonstration, problem, or video clip to capture the student's attention and introduce the lesson. The engage activity involves exciting the senses of the learner in a new or novel way.

Explore – During the explore activity, the student becomes directly involved with a particular phenomena by manipulation of materials that are used to discover the phenomena. As students participate in the exploration, they build a common knowledge base with other students and share information about the learning experience. Instruction is driven via inquiry, and the teacher facilitates instruction.

Explain – The student communicates in verbal and written form about information derived from the learning experience. Communication occurs on many levels: learner reflection, peer to peer, student to teacher, media tools. Articulation of observations, inferences, questions, and hypotheses is an important aspect of science, and students should practice communicating what they know and are able to do with regard to the learning experience. The teacher may want to introduce specific vocabulary terms to facilitate communication of understandings about the lesson

Elaborate – During the elaboration phase, student expand their knowledge by making connections about what they have learned and applying this new knowledge to real world situations. Elaboration helps the student to internalize the concept and recognize it in many forms, not just the form in which it was taught.

Evaluate – Evaluation throughout the learning experience is an ongoing process and has a diagnostic function. Communication of concrete evidence of learning to the student, parents, and administrators is a vital tool needed to maximize the learning process. Evaluation can result in reteaching a particular concept. Evaluation can reveal that students do not have the prerequisite knowledge necessary to learn a science concept. Evaluation can

also be used to identify student misconceptions so they may be reconstructed to match scientific concepts. Of course, evaluation is also used to identify when students have mastered a particular concept. Finally, evaluation consists of traditional and authentic assessment methods. Examples, of tradition assessment include multiple choice tests, matching test, and fill in the blank tests. Examples of authentic assessment methods include rubrics, checklists, journaling, and portfolios.

Identifying Power Standards

Discussion

“How can I get it all taught?” This refrain is heard constantly from teachers, who often try to “cover” content and skills, using standards as a kind of checklist. It is an excellent practice to remember that it does not matter what a teacher “covers.” It only matters what a student actually learns.

To help shift the emphasis from covering content to facilitating achievement by students, Larry Ainsworth and the Center for Performance Assessment suggest that teachers focus on *Power Standards*.

Power Standards are *prioritized* standards that are derived from a systematic and balanced approach to distinguishing the standards that are absolutely essential for student success from those that are "nice to know." Power Standards are a subset of the complete list of standards for each grade and for each subject. They represent the "safety net" of standards that each teacher needs to make sure that every student learns prior to leaving the current grade. Students who acquire this "safety net" of knowledge and skills will thus exit one grade better prepared for the next grade. (Center for Performance Assessment, 2004).

He suggests that schools or districts can collaboratively prioritize standards, identifying those that are so important that students be given frequent and multiple opportunities for success and those that may be appropriately addressed in less depth and breadth.

Even though the TEKS for the middle grades only identify 14 concepts and skills, the ones identified are essential and pivotal for understanding science, they still differ in scope. Some are content specific; others are global and need to be taught over and over throughout a student's academic career. For example, a student's understanding of how to conduct an experiment may develop as a student matures, but its importance is ongoing. It is a “Power Standard.”

Other standards are Power Standards because they “lead” other standards; in other words, several other standards naturally cluster with them. For example, when you are teaching standard 8.3, “...uses ... scientific problem solving ...” it is natural to include those elements listed as 8.3, A-E. At least it is natural if you have reflected on what scientific problem solving is. The perfect situation is when you say to your students, “We are

going to do some scientific problem solving,” and they immediately assume that includes analyzing, reviewing, and critiquing scientific explanations; drawing inferences; using models; and evaluating impact.

One way to ensure this happens is to have a standard rubric for Power Standards that you use consistently. Students will then become aware of what these Power Standards include and will understand the depth and breadth of knowledge and skills included in their achievement.

Another technique identified by Ainsworth (2003) is the use of the *Big Idea*. It is so easy, when trying to address standards, to get lost in the details and fail to see the purpose behind a standard or group of standards – the old “seeing the trees but not the forest” syndrome. For example, it would be easy to become so involved in having students memorize what uplifting is and how to recognize patterns of water erosion that one might forget to make the connection between force and motion, or a student could be able to summarize the rock cycle, but not recognize that it demonstrates the relationship between structure and functions in Earth systems. For that reason, the TEKS are arranged by knowledge and skills (the first column) and then by what the student is expected to do (second column). Effective teachers constantly refer back to the *Big Ideas* (the knowledge and skills) so that the purpose of the student activities is not lost. *Big Ideas* give students context for specific knowledge and skills and provide integration for their scientific knowledge.

Activity 1: Find the Big Idea

The black-line master for the Big Idea worksheet can be found at the end of this chapter. The answer sheet is found below.

Write the *Big Idea* referenced by each activity listed in the chart below. The first one is done for you as an example:

Activity	Big Idea
Layout the chronology of events that lead to the development of the modern atomic theory.	Use critical thinking and scientific problem solving to make informed decisions.
Describe serotonin production as part of a negative feedback system.	Interdependence occurs among living systems.
Correctly complete a Punnett Square.	Traits of species change through time; the information for those traits is contained in the genetic material.
Explain how substances lose or gain heat during a chemical reaction.	Complex interactions occur between matter and energy.
Demonstrate a chemical reaction that produces a gas.	Substances have physical and chemical properties.
Measure the terminal velocity of a falling parachute.	There is a relationship between force and motion.
Identify the charges associated with the electron, proton, and neutron.	Matter is composed of atoms.
Compare how a wave travels through water and through rock.	There is a relationship between force and motion.
Explain how the ocean affects weather.	Complex interactions occur between matter and energy.
Record data in a table and create a graph using that data.	Use scientific inquiry methods.

Activity 2: Identify Power Standards

Individually or (preferred method) in small groups, review the middle grades science TEKS. They can be found at <http://www.tea.state.tx.us/rules/tac/chapter112/ch112b.html>.

Identify what you consider to be the Power Standards. Give reasons for your choices.

Activity 3: Create a Rubric for a Power Standard

Previously we stated that one way to ensure that learners recognize the breadth and depth of a Power Standard is to have a rubric for it that you use consistently. Individually or in small groups create a rubric for one of the Power Standards you identified in Activity 2. You may choose to use a rubric tool such as that found at: <http://rubistar.4teachers.org/index.php>.

Reflect

In small groups, discuss whether you think the identification and use of Power Standards would help you support student achievement. Give reasons for your opinion and, whenever possible, give specific examples.

References:

Ainsworth, L. (2003). *Power standards: Identifying the standards that matter the most*. Denver, CO: Advanced Learning Press.

Center for Performance Assessment (2004). Making standards work series: Power standards. Retrieved on April 4, 2004, from http://www.makingstandardswork.com/professional_development/power_standards.htm

High Plains Regional Technology in Education Consortium. (2003). Rubistar. Retrieved on April 6, 2004, from <http://rubistar.4teachers.org/index.php>.

Texas Education Agency (1998). *Chapter 112. Texas essential knowledge and skills for science subchapter b. middle school*. Retrieved on April 6, 2004, from <http://www.tea.state.tx.us/rules/tac/chapter112/ch112b.html>

Using Models in Science

Objective: Clarify what a model is and how it can, and should, be used in science

TEKS: 8.5 A and B

- Design and test a model to solve [a] problem
- Evaluate the model, and
- Make recommendations for improving the model.

What is a model?

The Merriam-Webster Online Dictionary (2004) states that the term *model* can be a noun, an adjective, or a verb. For the noun alone, it gives twelve meanings. Only by combining some of these meanings do we adequately approach how the word *model* is used in science. "...a description or analogy used to help visualize something..." (#11), "a usually miniature representation of something; *also*: a pattern of something to be made" (#4); "a system of postulates, data, and inferences presented as a mathematical description of an entity or state of affairs" (#12). (Merriam-Webster, 2004). All of these meanings apply sometimes to models we use in science.

By the time we are adults, we have used models so frequently that we rarely think about what a model is, why it is used, and what are its strengths and weaknesses. Consequently, we rarely clarify these concepts for students. This may lead to student misconceptions and lessen the power of model use. It may also hinder students from creatively constructing models of their own to explain objects, events, and processes.

A model is something that can be used to enhance our understanding because it shares certain characteristics with the object of study. By definition it also differs in many ways from what it models. If it were not different, it would not be a model; it would be the "real thing."

Models are essentially analogies. We can apply what we know about the model to an identical or similar characteristic in the object of study so that we can understand it better. For example, we often use the flow of water in pipes to model the movement of charge in an electrical system. Although the two processes are really very different, many of the concepts we use to understand the different forces in the water system are also useful to explain different forces in the electrical system. Similarly, we use "tinker

toys” to model molecular bonding, although the two processes are not really very much alike; but the ways in which they ARE alike are the very qualities of most interest to us; i.e. we can join objects together in different combinations based on the number and location of the “holes”.

Why use models at all? We may decide to use a model because the real object of study is too big, too small, too complex, too hard to find, to isolate, or to manipulate, or for some other reason is difficult to study on its own. For example, atoms are too small to study by commonly available means; a solar system is too big and can't be manipulated. Global warming and other weather systems can be studied best with computer modeling because they are so complex.

Models are most helpful to our conceptual understanding. They can provide hypotheses, suggesting what variables might be important and what relationships might exist. A student (or teacher) should never forget that there are differences between a model and the actual phenomena; thus we must be careful and thoughtful about the inferences we make using models. By clarifying how the model differs from the object of study, it can help us avoid forming misconceptions or making inferences that do not follow. For example, when students make drawings of the process of cell division, they may fail to realize that the drawings only show “snapshots” of a moving process. They may not recognize the “in-between” stages. When shown real cells in the process of reproducing, students may not be able to make sense of what they see if the parts of the cell are not exactly located as they were in the drawings. When we model cell division by walking or dancing through the process, the dynamic nature of the process is more like “the real thing,” but it will not help students recognize what this process actually looks like in cells. People do not look a bit like chromosomes. For this reason, it may be helpful to use several different kinds of models for the same thing and to clarify for students what characteristics are shared between the model and the real thing and what characteristics are not shared.

Best practices:

- Choose models carefully.
- Know why you chose a model; think about its strengths and weaknesses as a model.
- Specifically discuss these points with students.
- Be open to new models suggested by or developed by students.

Understand and clearly explain to students the relationship between a model and the object, process, or system it represents. Every time you use a model or ask students to create a model, at some point in the process ask:

- Why are we using a model instead of directly studying the real thing?
- What characteristics does this model share with the real object of study?
- In what ways is it different?
- What other models could we use?
- Is this a good model for us to use? Why or why not?

5 E's

Engage

Probing Questions:

- What is a model?
- What kinds of models are there?
- What do all models have in common?
- How can models be used in science and mathematics?
- What should scientists and other scholars remember when using models?

Ask the students if they know what a model is and how models are used in science. Accept all answers.

Demo: Volcano One

Prepare two models of volcanic eruption to demonstrate to the learners. For model one, use a volcanic cone made of paper, plaster, clay, or any other convenient material. Put a small amount of baking soda (15 mL) in the depression representing the caldera of a volcano. Add a few drops of red food coloring. Ask the learners what they know about volcanoes and volcanic eruptions. After a short brainstorming session, pour a small amount of vinegar (50 mL) into the cavity. The baking soda and vinegar will react, bubbling over. Ask learners to describe how this models a volcanic eruption. Ask:

1. How is this model like a real volcano? What characteristics does it share with a real volcano?
2. In what ways is it different?
3. What other models could we use?
4. Is this a good model for us to use? Why or why not?

Demo: Volcano Two

Show the learners a second model, which is a mixture of Plaster of Paris, water, and food coloring. Mix the Plaster of Paris and water according to the directions on the Plaster of Paris box. Add food coloring. You may add about 5 mL vinegar to the mixture to slow hardening of the mixture, which is important to this demonstration. Lay the bag down flat on the table. Poke a hold in the bag with a pencil and push down on it until the Plaster mixture oozes out. Repeat the questions you asked when showing the soda-vinegar experiment. Help learners understand that in a real volcanic eruption it is not the mixing of chemicals that causes the lava to flow out; it is heat and pressure. Ask:

Which of these is a better model? Why? [Note: Each of these models has strengths and weaknesses. For example, the soda-vinegar one looks more like what we see when we see movies of volcanic eruptions. It also produces gas, and gasses are often released with volcanic eruptions. The plaster model, however, more closely represents the physical pressures that produce lava flows].
Why are we using a model at all? Why don't we study the real thing?

Ask learners how these models could be improved, or if they can think of something else that would make a better model. [Example: Using heat AND pressure might represent the real process better, but it would be more dangerous in the classroom.]

Explore

Have learners, in small groups, complete the activity *Making a Model from an Object*, see Black-Line Masters. If possible, allow enough distance between the groups that they cannot fully see how the other groups are drawing their model. This encourages variety in the ways the groups realize their models and provides for a rich discussion. When the learners have all finished their group drawing, let each group look at the drawings of the others. Discuss whether there were differences in how the different groups drew their models and why. Discuss the fact that the toy cars and all the drawings were models of a real car. Ask learners to comment on the strengths and weaknesses of each model. Ask learners what you could know about a real car from only looking at the models. Would it be possible to form misconceptions from the models? If you knew little or nothing about cars, what could you learn about cars from the toy models? From the drawings?

Key vocabulary:

Model: something that can be used to enhance our understanding because it shares certain characteristics with the object of study.

Scale: a standard ratio between two sets of dimensions (i.e. the ratio between corresponding parts of the two objects is constant, even if the two objects are of different sized)

Ratio: the relation of one part to another in respect to magnitude, quantity, or degree

Analogy: inference that if two or more things agree with one another in some respects they will probably agree in others (Merriam-Webster, 2004, #1).

Limitations: boundaries, restrictions

Process skills: Designing, using, and evaluating models

Overview

Learners engage in a hands-on activity in which they determine the mathematical relationship between an object (an automobile) and one kind of model (a toy car) and then use that mathematical relationship to create a second kind of model (a toy-sized drawing).

Explain

Applications: Discuss models. List models used in science. Discuss why it is important to use models cautiously in teaching.

Elaborate

Applications: Learners will work in small groups to create a rubric for evaluating models. They may use a form provided by the teacher, use Rubistar (<http://rubistar.4teachers.org/index.php>), or use a format of their own creation. During the process of creating a rubric, learners will have to reflect deeply on the nature and value of models.

Take it home: Learners or small groups of learners may apply what they have learned about models by:

Exploring the emergence of important models in the history of science, such as:

- Models of the atom
- Models of the process of reproduction
- Models of the etiology of infectious disease

Investigating the social and political importance of the acceptance by the scientific community of different models; e.g.

- Models of the process / causes of evolution (Lamarck, Darwin, Cataclysmic Event, etc.)
- Models of the solar system (Ptolomy, Capernicus, Galileo)

Learners may make presentations of the teachers' choice (oral, written, multimedia) relating what they have learned.

Evaluate

Assessment tools: Rubric for evaluation of a model.

Use the Rubric to evaluate a model of a molecule, a cell, or the solar system. Explain your evaluation.

References:

Merriam-Webster (2004). *Merriam-Webster online dictionary*. Retrieved on April 4, 2004, from <http://www.m-w.com/cgi-bin/dictionary?book=Dictionary&va=model>.

Merriam-Webster (2004). *Merriam-Webster online dictionary*. Retrieved on April 4, 2004, from <http://www.m-w.com/cgi-bin/dictionary?book=Dictionary&va=model>.

Systems and Cycles

Objective: Explore the meaning and application of the concepts *system* and *cycle* in the study of science

TEKS: Systems

6.5. The student knows that systems may combine with other systems to form a larger system.

6.10, 7.9. The student knows the relationship between structure and function in living systems.

6.13, 7.13. The student knows components of our solar system.

6.14. The student knows the structures and functions of Earth systems.

7.5, 8.14. The student knows that the equilibrium of a system may change.

7.14, 8.14 The student knows that natural events and human activity can alter Earth systems.

8.6. The student knows that interdependence occurs among living systems

TEKS: Cycles

6.8.B. Explain and illustrate the interactions between matter and energy in the water cycle and in the decay of biomass such as in a compost bin; and

6.8.C. Describe energy flow in living systems including food chains and food webs.

6.14.A. Summarize the rock cycle

8.12 The student knows that cycles exist in Earth systems.

8.12.A. Analyze and predict the sequence of events in the lunar and rock cycles.

8.12.C. Predict the results of modifying the Earth's nitrogen, water, and carbon cycles.

Background:

The term *system* is used extensively throughout the science TEKS. It is a key term in scientific literature. When we reflect on the term, however, we may find that although we have an operational definition (i.e. we can use the term meaningfully in expressing our thoughts), we may not be clear about exactly what the term means. We may not clearly understand the implications that derive from the fact that a group of elements form a system. If we, as teachers, are unclear, then we cannot expect our students to have a clear conceptual and functional understanding of this important term. If we help students clarify the term and understand these implications, then they can apply this concept to any system.

A search on the web < <http://www.google.com/search?q=define:system> > shows that the term is defined in many ways and has many shades of meaning. For our purposes, we will start with a basic definition, but part of your task in this lesson is to develop your own definition of the term.

The TEKS state:

A system is a collection of cycles, structures, and processes that interact. Students should understand a whole in terms of its components and how these components relate to each other and to the whole. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems and can be observed and measured as patterns. These patterns help to predict what will happen next and can change over time.
(TEA, 1999).

These definitions show us that systems have certain characteristics, including:

- Systems have parts, but these parts work together to form a whole. The whole has characteristics and capabilities that are more than the sum of the parts.
- Systems have boundaries, parts, input and output, and feedback. Think of a hurricane system.
- A change in any part of a system may, and probably will, affect other parts of the system.

- A system may have characteristics and capabilities more than or different than any or all of its parts.
- Systems may have different levels of organization.
- Systems may have different properties and functions at different levels of organization.
- Systems may combine with one or more other systems to form a larger system; likewise, there may be any number of systems within a system.

So if the preceding list describes the characteristics of a system, what's a cycle? A cycle is one kind of a system; it is a system in which the events recur, establishing a pattern. Since a cycle is a system, it has all the characteristics of a system, with the added characteristic that events recur.

The natural and created worlds are full of systems and cycles; therefore, so is the study of science. It is essential that students have a deep and clear understanding of what these terms mean.

Best practices:

When studying systems, and cycles as a kind of system, help students identify what they know because the object of study is a system: i.e.:

- It has parts that work together. What are those parts?
- It has characteristics and capabilities more than the sum of the parts. What are some of these?
- It has boundaries. What are its boundaries? What is part of the system and what is not?
- It has input, feedback, and output. Identify these.
- A change in one part of the system may, and probably does, affect other parts of the system. What would happen if...?
- Systems may have different levels of organization. Can we demonstrate this organization of a system (draw?) showing different levels of organization?
- Systems may combine with one or more other systems or have subsystems. Which systems are part of this system? Of what larger systems might this system be a component?

5 E's

Engage

Probing Questions:

5. What is a system?
6. Can you name some systems?
7. What characteristics do all these systems have?

Ask students to brainstorm as many examples of systems as they can. Write them on a transparency, computer for projection, or on the chalkboard. Ask students how they know these are systems. Ask them if they encountered an entirely new system, how would they know if it was a system? After they figured out it was a system, what kinds of information would have about it just because it was a system? Show them the examples you have assembled, one at a time and ask whether it is a system, and if so, why. Include some non-examples, (ex. A rock, a potato, a hat ...). Note: be prepared for students to identify systems in objects that you thought were non-examples. Have them explain and examine their explanations for misconceptions or for creative applications of the concept]. If students identify something as a non system, have them explain their reasons. Do not correct student answers at this time. You will return to this.

Explore

Key vocabulary:

- System (note: students will develop their own definition of system as a part of this activity)

- Input: anything that comes into a system and is necessary for its functioning
- Output : anything that comes out of a system as a product of the actions of that system
- Feedback: the process in which part of the output of a system is returned to its input in order to regulate its further output (Princeton, n.d.)

In small groups, have students examine many different definitions of the word system, from reference books or from the web. <http://www.google.com/search?q=define:system> would be a good reference for them. Have each group decide on a definition for system or develop their own definition based on their understanding of the concept. Have each group present their definition. During a class discussion, choose one definition to represent the class. Help students understand that multiple definitions are not uncommon for complex concepts and can help us deepen our understanding of a concept.

Explain

During a class discussion, have students brainstorm a list of characteristics that all systems have. You can use the examples from the original brainstorming session to prompt students. Ask questions and make suggestions until all the characteristics in the *Teacher Background* information have been put on the list.

Applications

Divide students into small groups. Each group will choose a system from the class-generated list. The group will complete the *Student Reflection Guide* for the system they chose. Have each group present their finished work and accept constructive feedback from their peers.

Elaborate

Elaboration 1

Applications/Take it Home: After completing the activity on systems, have students use what they know about systems to create a “gidget” that is a system. They will draw the gidget or make a model. Each student will complete the Student Reflection Guide for his/her gidget so that his/her classmates will know the system’s parts, function, input, output, feedback loops, etc. Have a gidget fair where all can show and explain their gidgets.

Elaboration 2

Expand the study to include cycles. Have students define cycles through the same process that you used in the explanation of systems.

Resource: <http://www.google.com/search?q=define:cycle>

Clarify for students that a cycle is a special kind of system. It has all of the characteristics of a system, but also has the characteristic of having a clearly discernable pattern of repetition. After students have defined cycle in a small group, ask each small group to complete a *Student Reflective Guide* for one of the following:

- Water cycle
- Energy and matter cycle in growth and decay of natural systems
- Rock cycle
- Nitrogen cycle
- Carbon cycle

Evaluate

Rubric for *Student Reflection Guide* activity (Black-Line Masters)

Resources:

Circle-Cycle Game: Retrieved on April 7, 2004, from www.nps.gov/wica/PDF/EE-5th_Grade-Cycle-Circle_Game.pdf

Google (2004). Definitions of system on the web. Retrieved on April 6, 2004, from <http://www.google.com/search?q=define:system>

Google (2004). Definitions of cycle on the web. Retrieved on April 6, 2004, from <http://www.google.com/search?q=define:cycle>

Princeton University (n.d.). WordNet 2.0 Search. Retrieved on April 6, 2004, from www.cogsci.princeton.edu/cgi-bin/webwn

High Plains Regional Technology in Education Consortium (2003). Rubistar. Retrieved on April 7, 2004, from <http://rubistar.4teachers.org/index.php>

What is Important? Retrieved on April 7, 2004, from www.nps.gov/wica/PDF/EE-5th_Grade-What_is_Important.pdf

Assessment

Just as the TEKS and instructional objectives tell us what students are expected to know and/or do, assessment provides the teacher with information about how students demonstrate this knowledge and/or skills. Together, the TEKS, instructional objectives, and assessment instruments guide the timing as well as the nature of the curriculum and strategies employed in a learning experience. For example, assessment helps the instructional process by:

- Determining how students are required to demonstrate their acquisition of knowledge and skills.
- Helping teachers to know when students are not making acceptable progress so a mastery plan can be implemented.
- Providing clues about the effectiveness of interventions that should occur when students do not acquire necessary knowledge and skills (remediation, peer tutoring, modified assignments).
- Directing the trajectory of the learning process.
- Identifying attributes associated with placement in and exit from special programs (e.g., gifted and talented programs for student who are not challenged by a regular curriculum or special education programs for students who require instructional modifications).
- Providing information about how students perform compared to other students within the school, district, state, or nation.
- Providing information about how students perform compared to other students within the school, district, state, or nation.

There are two broad categories of assessment. Formative assessment takes place during the instructional process and lets the teacher know if students are meeting learning objectives, if the learning experience is running on schedule, and if there are ways to improve the learning experience while it is in progress. Formative assessment helps students to learn more effectively. In contrast, summative assessment occurs at the end of a

program and is used to determine its overall effectiveness. Summative assessment provides evidence that the program is satisfactory and should be continued or that student learning and/or attitudes are so negative that a new program is needed. Without summative assessment, teachers would continue to teach ineffectively and ineffective programs would continue.

Read and respond to the anticipation guide for Fundamental Assessment Principles for Teachers and School Administrators (see Black-Line Masters).

Fundamental Assessment Principles for Teachers and School Administrators

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While several authors have argued that there are a number of "essential" assessment concepts, principles, techniques, and procedures that teachers and administrators need to know about (e.g. Calfee & Masuda, 1997; Cizek, 1997; Ebel, 1962; Farr & Griffin, 1973; Fleming & Chambers, 1983; Gullickson, 1985, 1986; Mayo, 1967; McMillan, 2001; Sanders & Vogel, 1993; Schafer, 1991; Stiggins & Conklin, 1992), there continues to be relatively little emphasis on assessment in the preparation of, or professional development of, teachers and administrators (Stiggins, 2000). In addition to the admonitions of many authors, there are established professional standards for assessment skills of teachers (*Standards for Teacher Competence in Educational Assessment of Students* (1990), a framework of assessment tasks for administrators (Impara & Plake, 1996), the Code of Professional Responsibilities in Educational Measurement (1995), the Code of Fair Testing Practices (1988), and the new edition of *Standards for Educational and Psychological Testing* (1999). If that isn't enough information, a project directed by Arlen Gullickson at The Evaluation Center of Western Michigan University will publish standards for evaluations of students in the near future.

The purpose of this article is to use suggestions and guidelines from these sources, in light of current assessment demands and contemporary theories of learning and motivation, to present eleven "basic principles" to guide the assessment training and professional development of teachers and administrators. That is, what is it about assessment, whether large-scale or classroom, that is fundamental for effective understanding and application? What are the "big ideas" that, when well understood and applied, will effectively guide good assessment practices, regardless of the grade level, subject matter, developer, or user of the results? As Jerome Bruner stated it many years ago in his classic, *The Process of Education*: "...the curriculum of a subject should be determined by the most

fundamental understanding that can be achieved of the underlying principles that give structure to that subject." (Bruner, 1960, p.31). What principles, in other words, provide the most essential, fundamental "structure" of assessment knowledge and skills that result in effective educational practices and improved student learning?

Assessment is inherently a process of professional judgment.

The first principle is that professional judgment is the foundation for assessment and, as such, is needed to properly understand and use all aspects of assessment. The measurement of student performance may seem "objective" with such practices as machine scoring and multiple-choice test items, but even these approaches are based on professional assumptions and values. Whether that judgment occurs in constructing test questions, scoring essays, creating rubrics, grading participation, combining scores, or interpreting standardized test scores, the essence of the process is making professional interpretations and decisions. Understanding this principle helps teachers and administrators realize the importance of their own judgments and those of others in evaluating the quality of assessment and the meaning of the results.

Assessment is based on separate but related principles of measurement evidence and evaluation.

It is important to understand the difference between measurement evidence (differentiating degrees of a trait by description or by assigning scores) and evaluation (interpretation of the description or scores). Essential measurement evidence skills include the ability to understand and interpret the meaning of descriptive statistical procedures, including variability, correlation, percentiles, standard scores, growth-scale scores, norming, and principles of combining scores for grading. A conceptual understanding of these techniques is needed (not necessarily knowing how to compute statistics) for such tasks as interpreting student strengths and weaknesses, reliability and validity evidence, grade determination, and making admissions decisions. Schafer (1991) has indicated that these concepts and techniques comprise part of an essential language for educators. They also provide a common basis for communication about "results," interpretation of evidence, and appropriate use of data. This is increasingly important given the pervasiveness of standards-based, high-stakes, large-scale assessments. Evaluation concerns merit and worth of the data as applied to a specific use or context. It involves what Shepard (2000) has described as the systematic analysis of evidence. Like students, teachers and administrators need analysis skills to effectively interpret evidence and make value judgments about the meaning of the results.

Assessment decision-making is influenced by a series of tensions.

Competing purposes, uses, and pressures result in tension for teachers and administrators as they make assessment-related decisions. For example, good teaching is characterized by assessments that motivate and engage students in ways that are consistent with their philosophies of teaching and learning and with theories of development, learning and motivation. Most teachers want to use constructed-response assessments because they believe this kind of testing is best to ascertain student understanding. On the other hand, factors external to the classroom, such as mandated large-scale testing, promote different assessment strategies, such as using selected-response tests and providing practice in objective test-taking (McMillan & Nash, 2000). Further examples of tensions include the following.

- Learning vs. auditing
- Formative (informal and ongoing) vs. summative (formal and at the end)
- Criterion-referenced vs. norm-referenced
- Value-added vs. absolute standards
- Traditional vs. alternative
- Authentic vs. contrived
- Speeded tests vs. power tests
- Standardized tests vs. classroom tests

These tensions suggest that decisions about assessment are best made with a full understanding of how different factors influence the nature of the assessment. Once all the alternatives understood, priorities need to be made; trade-offs are inevitable. With an appreciation of the tensions teachers and administrators will hopefully make better informed, better justified assessment decisions.

Assessment influences student motivation and learning.

Grant Wiggins (1998) has used the term 'educative assessment' to describe techniques and issues that educators should consider when they design and use assessments. His message is that the nature of assessment influences what is learned and the degree of meaningful engagement by students in the learning process. While Wiggins contends that assessments should be authentic, with feedback and opportunities for revision to improve rather than simply audit learning, the more general principle is understanding how different assessments affect students. Will students be more engaged if assessment tasks are problem-based? How do students study when they know the test consists of multiple-choice items? What is the nature of feedback, and when is it given to students? How does assessment affect

student effort? Answers to such questions help teachers and administrators understand that assessment has powerful effects on motivation and learning. For example, recent research summarized by Black & Wiliam (1998) shows that student self-assessment skills, learned and applied as part of formative assessment, enhances student achievement.

Assessment contains error.

Teachers and administrators need to not only know that there is error in all classroom and standardized assessments, but also more specifically how reliability is determined and how much error is likely. With so much emphasis today on high-stakes testing for promotion, graduation, teacher and administrator accountability, and school accreditation, it is critical that all educators understand concepts like standard error of measurement, reliability coefficients, confidence intervals, and standard setting. Two reliability principles deserve special attention. The first is that reliability refers to scores, not instruments. Second, teachers and administrators need to understand that, typically, error is underestimated. A recent paper by Rogosa (1999), effectively illustrates the concept of underestimation of error by showing in terms of percentile rank probable true score hit-rate and test-retest results.

Good assessment enhances instruction.

Just as assessment impacts student learning and motivation, it also influences the nature of instruction in the classroom. There has been considerable recent literature that has promoted assessment as something that is integrated with instruction, and not an activity that merely audits learning (Shepard, 2000). When assessment is integrated with instruction it informs teachers about what activities and assignments will be most useful, what level of teaching is most appropriate, and how summative assessments provide diagnostic information. For instance, during instruction activities informal, formative assessment helps teachers know when to move on, when to ask more questions, when to give more examples, and what responses to student questions are most appropriate. Standardized test scores, when used appropriately, help teachers understand student strengths and weaknesses to target further instruction.

Good assessment is valid.

Validity is a concept that needs to be fully understood. Like reliability, there are technical terms and issues associated with validity that are essential in helping teachers and administrators make reasonable and appropriate inferences from assessment results (e.g., types of validity evidence, validity generalization, construct underrepresentation, construct-irrelevant variance, and discriminant and convergent evidence). Of critical importance is the concept of evidence based on consequences, a new major validity category in the recently revised *Standards*. Both intended and unintended consequences of assessment need to be examined with appropriate evidence that supports particular arguments or points of view. Of equal importance is getting teachers and administrators to understand their role in gathering and interpreting validity evidence.

Good assessment is fair and ethical.

Arguably, the most important change in the recently published *Standards* is an entire new major section entitled "Fairness in Testing." The *Standards* presents four views of fairness: as absence of bias (e.g., offensiveness and unfair penalization), as equitable treatment, as equality in outcomes, and as opportunity to learn. It includes entire chapters on the rights and responsibilities of test takers, testing individuals of diverse linguistic backgrounds, and testing individuals with disabilities or special needs. Three additional areas are also important:

- Student knowledge of learning targets and the nature of the assessments prior to instruction (e.g., knowing what will be tested, how it will be graded, scoring criteria, anchors, exemplars, and examples of performance).
- Student prerequisite knowledge and skills, including test-taking skills.
- Avoiding stereotypes.

Good assessments use multiple methods.

Assessment that is fair, leading to valid inferences with a minimum of error, is a series of measures that show student understanding through multiple methods. A complete picture of what students understand and can do is put together in pieces comprised by different approaches to assessment. While testing experts and testing companies stress that important decisions should not be made on the basis of a single test score,

some educators at the local level, and some (many?) politicians at the state at the national level, seem determined to violate this principle. There is a need to understand the entire range of assessment techniques and methods, with the realization that each has limitations.

Good assessment is efficient and feasible.

Teachers and school administrators have limited time and resources. Consideration must be given to the efficiency of different approaches to assessment, balancing needs to implement methods required to provide a full understanding with the time needed to develop and implement the methods, and score results. Teacher skills and knowledge are important to consider, as well as the level of support and resources.

Good assessment appropriately incorporates technology.

As technology advances and teachers become more proficient in the use of technology, there will be increased opportunities for teachers and administrators to use computer-based techniques (e.g., item banks, electronic grading, computer-adapted testing, and computer-based simulations), Internet resources, and more complex, detailed ways of reporting results. There is, however, a danger that technology will contribute to the mindless use of new resources, such as using items on-line developed by some companies without adequate evidence of reliability, validity, and fairness, and crunching numbers with software programs without sufficient thought about weighting, error, and averaging.

To summarize, what is most essential about assessment is understanding how general, fundamental assessment principles and ideas can be used to enhance student learning and teacher effectiveness. This will be achieved as teachers and administrators learn about conceptual and technical assessment concepts, methods, and procedures, for both large-scale and classroom assessments, and apply these fundamentals to instruction.

Notes:

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Authentic Assessment

Authentic assessment attempts to measure what students have actually learned and is much more challenging to use than traditional assessment techniques such as quizzes and multiple-choice tests. The reason authentic assessment instruments are more challenging to use than traditional assessment techniques is that authentic assessment relies on context and has a more qualitative orientation than traditional assessment techniques. In fact, exceptional teachers employ authentic assessment techniques because they allow the teacher the opportunity to gain insight into the thought processes of the student that are sometimes not possible using traditional assessment techniques. It's as close as we can get to looking inside a student's head! This insight helps to develop authentic learning experiences based on these understandings because the individual student is actively involved in the construction of meaningful understandings that are oftentimes difficult or impossible to ascertain with traditional assessment techniques. Teachers can use this information to guide the student down the yellow brick road to understanding. With my own children and students, it has made the difference between them performing like programmed robots and being able to use information to solve real-life problems.

The information that follows is an overview of authentic assessment techniques that can be employed in a classroom. Examples of each technique are presented and the advantages and disadvantages are discussed.

Journals

- Journals are an excellent way to document how a student constructs knowledge. Journaling can be used to:
- Promote literacy.
- Provide insight on what is going on in a student's life that might impact the learning process.
- Demonstrate growth and promote reflection.
- Answer and ask questions related to a particular topic.
- Collect other forms of data.

For example, in science class my students kept journals about lifecycles of various organisms we studied. In the journals the students recorded observations, inferences, drawings, diagrams, and made predictions about what they thought might happen next with regard to lifecycle of the organisms we were studying. Many times journaling can uncover misconceptions students have about concepts that are central to their understandings about specific topics. Most students were surprised to find

that fruit flies laid eggs on fruit and vegetables and maggots hatched out of these eggs. They were also unaware that the flower of an angiosperm would produce seeds and that seeds did not require light to germinate.

Checklists

Checklists are tools that can be used when the student engages in self-assessment or the teacher wants to know whether certain elements are present in an assignment. In a lab report, students could use a checklist to make sure they had included an introduction, hypothesis, materials list, results, conclusions, and implications section on their report. Checklists generally do not assign a value to the element, but rather just provide a method to note that the element is present in some form. Checklists can be useful to record affective behaviors. This is similar to placing a star on a chart for brushing your teeth, making your bed, and feeding the cat. For example, in a graphing activity students could be asked to check for critical information that should be on the graph before handing it in.

Checklist for Graphing Activity

- _____ Title (grammatically correct)
- _____ Dependent and independent variable are appropriately labeled
- _____ The type of graph is appropriate (bar or line)
- _____ Scale is appropriate and uses at least half of the graph paper
- _____ Points or bars are accurately represented
- _____ Key is present and accurate

Rubrics and rating scales

When students engage in performance-based assessment, the teacher seeks to measure the degree to which a student can successfully perform a task. This is easily accomplished by creating a rubric. A rubric allows the teacher to determine a number of preselected criteria to evaluate, and then design a continuum of proficiency levels (e.g., needs improvement, proficient, excellent) for the criteria. If students are not involved in the process of creating the rubric, then they should be given the rubric before they begin the project. It is best to provide examples of work that represent different levels of the rubric. However, the first time a new project is undertaken, it may not be possible to provide examples. Most of the time you will need to develop your own criteria for the rubric.

Airasian (1991, p, 244) recommends the following procedure:

1. Identify the task to be assessed and perform it or imagine yourself performing it.
2. List the salient aspects of the task.
3. Limit the number of performance criteria. Strive for simplicity.
4. If possible, ask other teachers to assist you in the development of the rubric.
5. Express the performance criteria in terms of observable behavior or project characteristics.
6. Arrange the criteria in the order in which they are most likely to be observed.

Rating scales usually employ a numerical scale where a number is assigned to each criterion on the scale. For example, when scoring a writing sample, on a scale of one to four, a score of one may represent more than five grammatical errors, a score of two may represent between 3 and 5 grammatical errors, a score of three may represent two or three grammatical errors, and a score of four may represent one or less grammatical errors.

Portfolios

A portfolio is a purposeful collection of a student's work and may be in paper form or in an electronic format. Portfolios document information about the individual they represent. For example, working portfolios are works in progress and provide examples that document personal growth and reflection. Some of the documents from a working portfolio may ultimately find their way into a display portfolio or an assessment portfolio. Display portfolios showcase an individual's best work, while an assessment portfolio documents what has been learned and is based on a set of predetermined standards.

Developing a portfolio is an excellent way to document evidence of competency in a particular subject area and to provide a context for reflection to guide long-term assessment of student growth and development. In the past decade, students have been granted increasing access to technological tools within an educational setting. As a result, many educators have moved away from using traditional hardcopy portfolios and instead rely on electronic portfolios. The benefits of such a decision are clear. Student work can be easily stored on CDs or within databases instead of in boxes or on shelves. Electronic portfolios allow the next grade-level teacher to instantly access information about a student or a particular group of students and then use this information to make inferences about how to maximize the learning experience for a particular individual or for a group of students.

According to Barrett (2000), there are several steps involved in the development of an electronic portfolio. While each stage of portfolio development contributes to lifelong learning, many portfolios stop at the selection stage. Teachers should strive to take student portfolios well beyond the selection stage to maximize the portfolio's usefulness.

Stages of Portfolio Development	
Collection	Teachers and students save artifacts that represent both successes and growth opportunities.
Selection	Teachers and students review and evaluate the artifacts they have saved and identify those that demonstrate achievement of specific standards.
Reflection	Teachers and students become reflective practitioners, evaluating their own growth over time and their achievement of the standards, as well as the gaps in their development.
Projection	Teachers and students compare their reflections to the standards and performance indicators, and set learning goals for the future. This is the stage that turns portfolio development into professional development and supports lifelong learning.
Presentation	Teachers and students share their portfolios with their peers. This is the stage where appropriate "public" commitments can be made to encourage collaboration and commitment to professional development and lifelong learning.
Barrett, Helen (2000). Electronic Portfolios = Multimedia Development + Portfolio Development: The Electronic Portfolio Development Process. http://transition.alaska.edu/www/portfolios/EPDevProcess.html	

Additionally, Seldin (1993) suggests several steps for compiling a portfolio that serve as useful guides for the development of student portfolios.

- Define the role of the teacher with regard to what needs to be documented.
- Select items for the Portfolio.
- Prepare a statement for each item. Why is the item included?
- Arrange the items in order. The order could be chronological to show growth over time or it could be based on categories such a particular TEK or TAK

Specific examples of student work that might be placed in a portfolio include:

- Teacher observations
- Reports
- Writing samples
- Drawings, charts, graphs, and other artifacts that are products of learning activities
- Video or audio tapes
- Awards or honors
- Journals and other forms of self-evaluation
- Letters from individuals who have knowledge about the student's participation in school sponsored extracurricular activities or outside
- Service organizations

Seldin, Peter and Associates (1993) Successful Use of Teaching Portfolios, Belton, MA: Anker Publishing.

Safety

The activities in the 8th grade Module have been used in Texas classrooms and are considered safe when proper procedure and safety protocols are utilized. Each lesson includes safety precautions and Materials Safety Data Sheets (MSDS) which accompany chemicals when they are purchased from a chemical supply company.

The key to lab safety begins *before* students enter the laboratory. It is mandatory that teachers become thoroughly familiar with local, district, and state guidelines regarding safe laboratory practice, and the handling and/or disposal of materials. For information about safety contact the safety office for the school. Safety information may also be obtained from various scientific supply companies that offer books, safety calendars, and videos regarding the creation of a safe learning environment in the laboratory (e.g., Sergeant Welch, Frey Scientific).

Once a safe learning environment has been created, the teacher should also thoroughly familiarize students with safety precautions and lab protocols before they begin laboratory activities. In order to document various safety precautions, we recommend the use of written safety contracts that are signed by both students and parents. Additionally, a safety quiz or similar test may be used as a way to assess students' knowledge about safety. Finally, safety violation forms and other anecdotal forms of documentation should be used to provide documentation that safety precautions and laboratory protocol is utilized over the course of the academic year. Safety contracts and safety violations forms may be purchased from chemical supply companies.

Black History Month

Find the Big Idea

Write the *Big Idea* which each activity references. The first one is done for you as an example:

Activity	Big Idea
Layout the chronology of events that lead to the development of the modern atomic theory.	<i>Use critical thinking and scientific problem solving to make informed decisions.</i>
Describe serotonin production as part of a negative feedback system.	
Correctly complete a Punnett Square.	
Explain how substances lose or gain heat during a chemical reaction.	
Demonstrate a chemical reaction that produces a gas.	
Measure the terminal velocity of a falling parachute.	
Identify the charges associated with the electron, proton, and neutron.	
Compare how a wave travels through water and through rock.	
Explain how the ocean affects weather.	
Record data in a table and create a graph using that data.	

Making a Model from an Object

Introduction

In studying science, we use many models, but what – really – is a model? How does a model compare with the actual object of study? In this activity, you will identify the relationship between one kind of model and the object it represents. You will then use this information to make a second model of the object.

Materials

Each group will need:

- a toy car
- a ruler
- a meter stick
- paper and pencil or pen

Procedure

1. Select a model car. For this activity, we are going to assume that the model car is produced *to scale*. In other words, that all of its parts have the same ratio to those parts in a real car. For example, if the tire is $1/50^{\text{th}}$ the size of the real tire, then the hood is also $1/50^{\text{th}}$ the size of the real hood, etc.
2. Measure the diameter of the tire on your toy car to use as your standard. Measure it carefully and record that measurement.

Toy tire diameter: _____ **cm**

3. Go into the designated area where you have access to real cars. Find a car that is similar to your toy car. Measure the tire of the real car that you measured on the toy car.

Real tire diameter: _____ **cm**

4. Compute the ratio of the two tires by dividing the measurement for the toy tire by the measurement of the tire for the real car. You will get a number that represents the ratio of toy parts to real parts.

measurement (toy) / measurement (real) = Ratio

5. Measure the items listed in the first column in the table by using your real car. Enter the data in the column entitled “Real.” Multiply by the ratio you got when you divided the toy by the real measure in #4. Enter the data in the column entitled “Model”. There is an added row for a measurement of your choice.

Remember, the formula you will use is:

$$\text{Real measurement (in cm)} \times \text{ratio} = \text{Model measurement (in cm)}$$

Measure these items:	Real (cm)	Model (cm)
Wheel base (the distance between the center of the front tire to the center of the back tire)		
Track (the distance between a left tire and a right tire)		
Length (the distance from the front of the car to the back of the car)		
Height (the distance from the ground to the top of the car)		
Front wheel to front bumper		
Back wheel to back bumper		
Distance from bottom of front windshield to bottom of back windshield		

5. Using the figures you computed for the model car, draw a model of a real car.
6. Reflect on your model. Discuss the following questions with your group in preparation for a whole-class discussion.

Questions

1. How is it like a real car?
2. How is it different from a real car?
3. If someone had never seen a real car – only the model that your group drew— what could that person learn about cars?
4. If someone had never seen a real car – only the model that your group drew— what misconceptions might that person have about cars?
5. What would you consider the strengths of your model?
6. What would you consider the weaknesses of your model?

Student Reflection Guide

Our group's definition of <i>system</i> :

Name of system:	
Function(s):	
Parts:	
Boundaries:	
Input:	
Output (products, waste materials, etc.):	
Are there one or more subsystems in your system? If so, what are they?	
Is your system part of one or more larger systems? If so, name the larger system.	

One characteristic of a system is that if a change is made to one part of the system, it may well have effects on other parts of the system or on the action of the system as a whole.

In the table below, list three parts of your system. State how that part might be changed and what effects you think that change would have on the system. An example is given for a parts of circulatory system.

<i>If this part were change...</i>	<i>...in this way...</i>	<i>...the results might be...</i>
Blood cells	Did not have enough iron in them	They couldn't hold oxygen, so not enough oxygen would get to the cells of the body no matter how hard you breathed.

System (or cycle) name: _____

<i>If this part were change...</i>	<i>...in this way...</i>	<i>...the results might be...</i>

Rubric for Student Reflection Guide Activity

Criterion	4	3	2	1
Conceptual understanding	Clearly understands the concept, lists all important characteristics and does not give any that do not fit concept, correctly identifies both examples and non examples and gives reasons	Shows good understanding of the concept, lists most important characteristics and does not give any that do not fit concept correctly, identifies examples and non examples, but does not give reasons	Shows some understanding of the concept and lists some characteristics, but omits key points, identifies examples and non example with some errors	Understanding of the concept has serious misconceptions, has difficulty identifying examples and non examples
Analysis	Analysis is thorough, insightful, and creative	Analysis is thorough, but contributes no new insights	Analysis is adequate, although some key points are omitted	Analysis is brief and inadequate, key points are omitted
Application	Applies knowledge in new situations correctly and without difficult	Applies knowledge in new situations correctly with some prompting	Applies knowledge in new situations, but with minor errors	Significant errors when knowledge is applied in new situations
Work Habits	Almost always listens to, shares with, and supports the efforts of others. Tries to keep people working well together.	Usually listens to, shares, with, and supports the efforts of others. Does not cause "waves" in the group.	Often listens to, shares with, and supports the efforts of others, but sometimes is not a good team member.	Rarely listens to, shares with, and supports the efforts of others. Often is not a good team player

*work habits cites from Rubistar group work rubric.

ANTICIPATION GUIDE FOR

Fundamental Assessment Principles for Teachers and School Administrators

Below are some statements about assessment and making choices about using assessment to guide the learning process. Read each statement carefully and write agree or disagree in the box under BEFORE YOU READ to indicate your initial opinion for the question. Read the article keeping those ideas in mind. After you have read the article, read each statement again and revisit your opinion. Do you still agree or disagree? Have you changed you mind? Write your final decision in the corresponding box in the AFTER YOU READ column and write an explanation as to why you hold your final opinion.

BEFORE YOU READ	AFTER YOU READ	STATEMENT
		There is no difference between evaluation and assessment. EXPLANATION:
		Assessment influences student motivation and learning. EXPLANATION:
		All assessments contain error. EXPLANATION:
		Multiple methods of assessment are critical to the learning process. EXPLANATION:
		Test banks are good resources for assessing student progress. EXPLANATION:

McMillan, James H. (2000). Fundamental assessment principles for teachers and school administrators. *Practical Assessment, Research & Evaluation*, 7(8). Retrieved April 6, 2004 from <http://PAREonline.net/getvn.asp?v=7&n=8> .