INTRODUCTION to Gateways

A Word to the Teacher

Before You Begin

Gateways to Science (*Gateways*) is not just a textbook; it is an instructional program designed around you, your elementary students, and the Texas Essential Knowledge and Skills (TEKS). It includes the structure, organization, balance, and presentation of content to meet the diverse needs of all students in the science classroom. Based 100% on the conceptual development of the state-mandated curriculum, the program promotes student success on the State of Texas Assessments of Academic Readiness (STAAR™), for which you and your students are held accountable.

The instructional program of *Gateways* is based on five guiding principles taken from the recommendations of the *National Science Education Standards*, the *Benchmarks for Science Literacy*, and other prominent works in the area of science education.

Science is for all students.

All students can achieve success in science if given the opportunity. Multiple experiences spaced over several years are required to develop the understanding of most scientific concepts and processes.

Learning science is an active process that includes both individual and social processing.

Effective science instruction requires both physical and mental activity on a regular and consistent basis. Students must have opportunities to develop understanding by sharing and refining their thinking individually and through peer interactions.

Students must accept and share responsibility for their own learning.

Teachers must set expectations for each student to take responsibility for his or her work in both individual and group settings.

Teachers must consistently model the habits of mind necessary for scientific literacy, including values, attitudes, communication skills, and critical thinking.

Curiosity, skepticism, honesty, willingness to communicate, and a strong persistence to think critically and solve problems must all be demonstrated and encouraged by the teacher.

Curriculum, instruction, and assessment must be aligned.

Teachers must maximize every minute of instructional time by remaining true to a close alignment among the components of curriculum, instruction, and assessment.

A Word to the Teacher

Student Edition

The lessons in the student edition are organized in a five-step learning sequence called the 5 E Model of Instruction. This sequence has proven to be a successful way for all students to actively learn science as well as other content. The model suggests that students rely on both prior experiences and firsthand knowledge gained from new explorations whenever they learn something new or understand something familiar in greater depth.

Let's Engage!

The first E introduces students to a new lesson. During these brief activities, students will make connections between something they learned in the past and something new they are about to learn. Students bring prior knowledge about how the world works, but it is sometimes based on limited experiences and sometimes on misconceptions.

Let's Explore!

The second E has students actively explore what they are learning. Students work as a team to plan, share, and discuss ideas as they learn about the topic. These activities are often, but not always, lab investigations. Experiences must occur before explanations. Students acquire a common set of experiences that allow them to help each other understand the concept through social interaction.

Let's Explain!

The third E puts students into meaningful discussions with their peers and teacher. After sharing information, students revise their thinking and record a science notebook entry that reflects their new understanding. When students engage in meaningful discussions with other students and the teacher, they can pool their explanations based on observations, construct new understandings, and have a clear focus for additional learning.

Let's Elaborate!

The fourth E has students apply or broaden their knowledge by using it in a different situation. These activities include making products, reading to learn, and additional lab investigations. Providing additional active learning opportunities for students to incorporate into their mental construct allows them to confirm and expand their understanding.

Let's Evaluate!

The fifth E gives students an opportunity to show what they have learned and are able to do. These activities allow both the student and the teacher to monitor and reflect on progress. In learner-centered instruction, it is important for students to be aware of their own progress as an outcome of instruction.

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Throughout *Gateways*, students are required to maintain a written science notebook or interactive notebook. The student edition asks students to record their thoughts, observations, collected data, drawings, and other information on a regular basis.

The back of the student edition includes an appendix that provides information and scoring rubrics for many of the learning strategies that are employed throughout the 5 E lessons.

Areas of Study

Each elementary grade level of *Gateways* is divided into four major units of study—

- Matter and Energy
- Force, Motion, and Energy
- Earth and Space
- Organisms and Environments

These four units of *Gateways* are based on the specific reporting categories for Elementary School Science STAAR.

The TEKS included under Scientific Investigation and Reasoning are embedded in the curriculum and will be taught throughout the school year.

Instructional Strategies

Gateways uses active, varied instructional approaches during the units of study. Students learn the "whys and hows" of science rather than just the "whats and whens." The built-in variety of instructional strategies helps motivate both teachers and students, while the built-in consistency of the lesson structure provides a familiar, nonthreatening learning environment.

Strategies for Activating Prior Knowledge

Brainstorming

Brainstorming is a process used to generate ideas for individuals or for groups. There are no "dumb ideas." Sometimes seemingly foolish ideas serve as a catalyst for other ideas. Brainstorming is not a debate, and it is not an evaluation of ideas. The quantity of brainstormed ideas is more important than the quality.

Possible organizational strategies to involve everyone in the process include:

- Teacher announces that everyone must generate three ideas on three separate sticky notes. Sticky notes are brought into a small-group discussion; all ideas are added to the group's list.
- A round-robin session involves every student contributing one idea to a group listing. Students may have permission to pass after the first round and the session continues until all group members have passed during a round.

Useful guidelines for brainstorming (Harmin, 1994):

- Accept every idea without judgment. Unusual ideas may generate new and valuable ideas.
- Write all ideas as they are offered. No judgment is involved at this point. Keep open minds during brainstorming.
- Generate ideas quickly. High energy and quick pace can lead to creativity and unusual ideas. If ideas are generated too fast for one recorder, utilize two or more recorders alternating writing during the process.

Mental Imagery

Research shows that engaging students in the creation of nonlinguistic representations stimulates and increases activity in the brain. The most direct way to generate nonlinguistic representation is to simply create a mental picture (Marzano, Pickering, & Pollock, 2001).

Strategies for Creating Learner-Centered Instruction

Stations

Classroom design and arrangement can directly facilitate or interfere with the learning climate in the classroom. Good spatial definition can help students feel secure by specifying for them where the structured learning areas begin and end. The spatial definition can define circulation patterns in the room during lab investigations, which also can define appropriate interaction patterns and help to guide students' work and behaviors. The way the stations are designed can ease the transition from one instructional activity to another.

Stations can be arranged visually to focus students' attention by—

- Using labels and signs to designate areas
- Using colors to attract visual attention and define spaces
- Taping lines on the floor or wall to define different work areas
- Moving furniture to define spatial boundaries
- Displaying group work, like a poster, to designate that group's space

Stations set up in the classroom should be arranged so that students have easy access to each other, to the teacher, and to the materials they need for the specific learning assignment (Johnson, Johnson, & Holubec, 1994).

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Cooperative Learning

Cooperative learning involves students working together to find success by accomplishing shared goals and involves students separated into small groups. The small groups work to increase each student's learning as well as the group's learning. Cooperation among students supports retention, motivation, task focus, achievement, and higher level thinking and reasoning. Working together, students develop a group relationship that is personal, social, and academic. Group work strengthens social competencies, supports student self-esteem, and enhances an individual's ability to cope with stress and adversity (Johnson et al, 1994).

Traditional cooperative learning in the science classroom involves students working together to achieve a common success. The group shares a common purpose that motivates each member beyond individual interests. Group members hold one another accountable for the quality of work accomplished. Group members promote each other's success by helping, explaining, and sharing. Group members are required to develop social skills to work effectively as a team. Groups can analyze how effectively goals are accomplished and can often summon the necessary motivation to increase the quality of learning. Ultimately, grouping encourages students to perform at a higher academic level than they probably would have if they were to work alone.

Lab Grouping

Students should be assigned to groups when they work together. One of the main reasons to use grouping is to ensure that each student actively participates (Johnson et al, 1994). Some decisions that must be made about lab groups include:

Determining the size of the group—

- Shorter time periods need small groups.
- Available materials or the specific nature of investigation may determine group size.
- Four students in a lab group support 12 interactions and help with role assignments:
    - Principal investigator: leads discussion to maintain group's focus and brings group to consensus
    - Materials manager: obtains and returns materials
    - Recorder: maintains group's written record; makes sure others keep individual records when needed
    - Reporter: presents group's work
- With fewer than four students, the reporter/recorder roles can merge; with more than four students, several can serve as recorders.

Assigning students to lab groups—

- A decision must be made to group homogeneously or heterogeneously.
- Advantages to heterogeneous grouping include:

- Multiple perspectives and problem-solving methods
- Increased cognitive disequilibrium to stimulate learning
- More frequent give-and-take of explanations
- Enhanced quality of reasoning and discussion
- Increased long-term retention

- Heterogeneous groups are often randomly assigned but can be teacher organized to maximize specific effects to accommodate isolated students, at-risk learners, disruptive behaviors, etc.

Keeping lab groups together—

- Over the course of a semester, students should have the opportunity to work with different classmates within a lab group.
- Groups should remain stable long enough to at least complete the specific lab tasks and recognize success.
- Students can be told that grouping assignments will change and that they will ultimately have the opportunity to work with everyone, or nearly everyone, in the class.

Strategies for Organizing Information

Learning is more powerful when students routinely take information presented in one format and represent it in an alternative way. Learning and retention can be improved by integrating information from both the verbal and the visual-spatial forms of representing and organizing information.

Concept Mapping

A concept map visually displays information by using main ideas and labeled lines. The concept map identifies relationships between important ideas and concepts, and it demonstrates a deeper, conceptual student understanding. Many students find it easier to make sense of information when it is presented in a visual format. The concept map can help students organize information by compressing, focusing, identifying connections, and supporting interpretation.

- Select a unit of work for concept mapping.
- Identify the major/minor concepts. Each concept may be put onto a separate piece of paper in order to rearrange them.
- Rank the concepts from most general to most specific.
- Arrange the most general concept at the top.
- Link this concept to the most specific concepts using straight lines.
- Label all lines with linking words that explain the relationship. Maps usually, but not always, read from top to bottom.

- Crosslinks can be used to show even more connections and relationships (Skoog & Lien, 1988).

Notebooking

Keeping a science notebook is an effective way for students to save information about experiences for future use and provides a way for students to reflect upon those experiences (Marcarelli, 2010). The process of notebooking:

- Creates a space for students to reflect about experiences and encourages insight into activities
- Allows students opportunities to create
- Encourages students to process what they are learning
- Allows for the free flow of students' ideas and feelings
- Gives a broader perspective over time and encourages students to reread and identify recurring themes
- Provides students with a safe format to communicate in a healthy and constructive way
- Involves student expression and exploration of thought

An interactive notebook is another tool students use in activating prior knowledge, recording learning experiences, and revising their thinking about the topic or concept. The input is the content learned, and the output is reflective thought gained through learning experiences. Benefits of the use of interactive notebooks are developing students' thinking skills, increasing communication, and differentiating instruction (Marcarelli, 2010).

Venn Diagrams and T-Charts

Having students identify similarities and differences among concepts being learned enhances their understanding of and ability to use knowledge (Marzano, et al, 2001). The use of a simple T-chart to have students organize their initial thinking while identifying the similarities and differences can be useful. A more sophisticated graphic called a Venn diagram has students display the similarities between elements in the intersection between two overlapping circles. The differences are placed in the parts of each circle that do not intersect.

Physical Models, Simulations, and Drawings

In general, physical models are concrete representations of knowledge, while simulations are representations of a process. Drawings may represent knowledge, process, or both. Models, simulations, and drawings are powerful ways to generate nonlinguistic representations in the mind. Each time students engage in transferring information into a new format that makes their thinking visible to others, their understanding increases.

A Word to the Teacher

Digital Cameras in the Science Classroom

Digital cameras can serve several purposes in the science classroom. To help students build vocabulary skills, have students take photographs to represent science terms being studied. Or introduce photos to students, asking them to identify science terms represented in images. Digital cameras can be used as data collection devices and as tools for creating digital collections of items such as leaves or insects.

Teacher Edition

Teacher pages include a materials list, basic instructions for each lesson, facilitation questions and answers, hints and suggestions for implementation, snapshot visuals of handouts and reproducible masters from the Teacher Resource CD, and answers to the questions and activities in the student edition. Pages from the student edition are embedded throughout the lesson to allow for ease of use when observing directions and activities. The *Gateways* Features page illustrates these components.

Teacher Resource CD

The CD included with each teacher edition of *Gateways* includes reproducible masters, lab station cards, manipulatives, and handouts for student distribution. Reproducible masters for assessments are also located on the CD. Assessments include Curriculum-Based Assessments (CBAs) that follow each unit. CBAs are written to both address the specific curriculum learned during a particular unit of study and spiral back to reinforce development of scientific investigations and reasoning skills.

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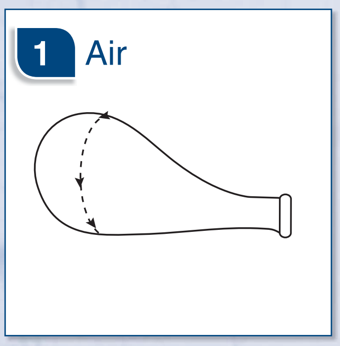
Gateways to Science Features

Safety Alert Icon
reminds teacher and students of safe lab practices.

Lab Rotation Icon
signals students to prepare for lab station activities.

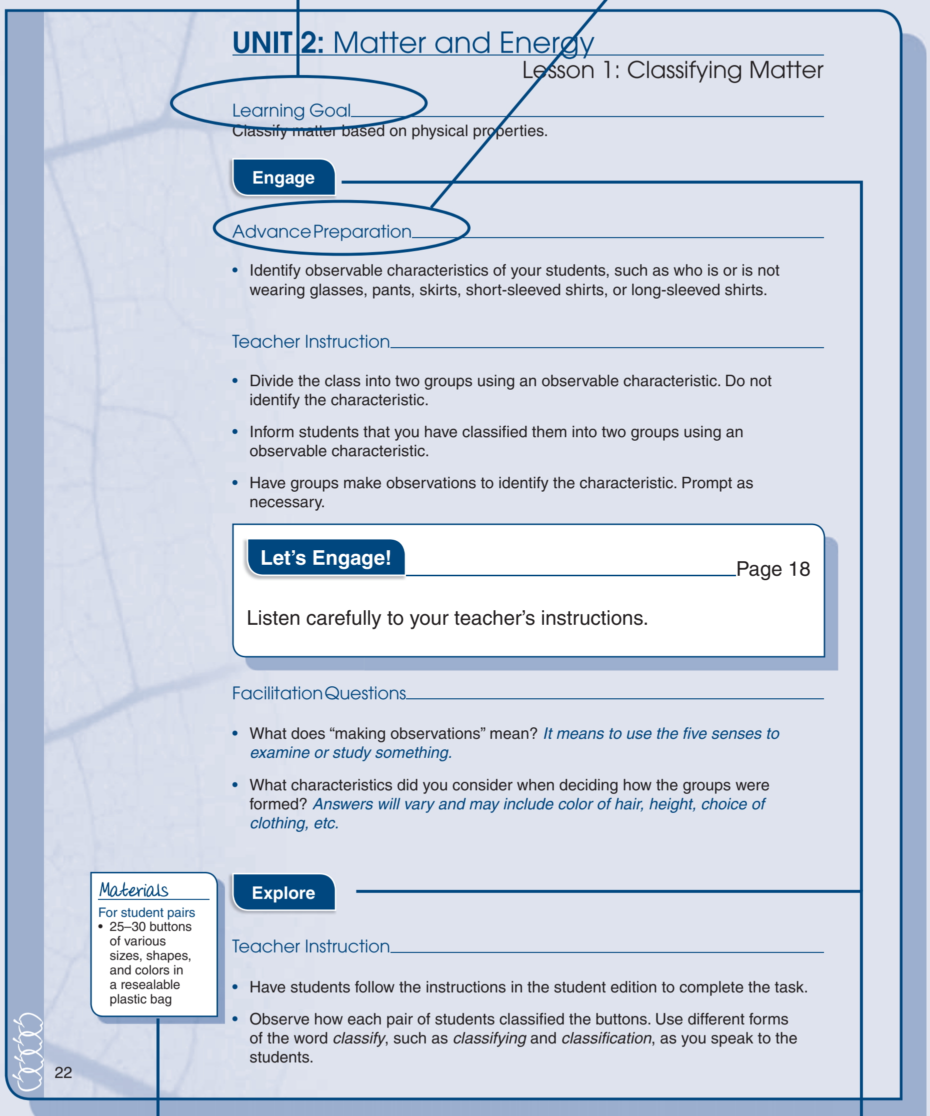
Stations



Station Descriptors
summarize for students lab activities by station.

Learning Goal
provides a brief outlook of lesson purpose.

Advance Preparation
allows for preplanning to ensure lesson goes smoothly.



UNIT 2: Matter and Energy

Lesson 1: Classifying Matter

Learning Goal

Classify matter based on physical properties.

Engage

Advance Preparation

- Identify observable characteristics of your students, such as who is or is not wearing glasses, pants, skirts, short-sleeved shirts, or long-sleeved shirts.

Teacher Instruction

- Divide the class into two groups using an observable characteristic. Do not identify the characteristic.
- Inform students that you have classified them into two groups using an observable characteristic.
- Have groups make observations to identify the characteristic. Prompt as necessary.

Let's Engage! Page 18

Listen carefully to your teacher's instructions.

Facilitation Questions

- What does "making observations" mean? *It means to use the five senses to examine or study something.*
- What characteristics did you consider when deciding how the groups were formed? *Answers will vary and may include color of hair, height, choice of clothing, etc.*

Materials

For student pairs
- 25–30 buttons of various sizes, shapes, and colors in a resealable plastic bag

Explore

Teacher Instruction

- Have students follow the instructions in the student edition to complete the task.
- Observe how each pair of students classified the buttons. Use different forms of the word *classify*, such as *classifying* and *classification*, as you speak to the students.

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Materials List
aids in lesson preparation.

5 Es
are clearly labeled to help keep track of lesson progress.

Lesson 1: Classifying Matter

- Instruct students to complete the science notebook entry as you circulate among the groups.

Let's Explore! Page 18

1. Observe the buttons.
2. Decide which physical property you will use to sort the buttons.
3. Classify the buttons.
4. Raise your hand when you are finished so your teacher can make observations of your work.

Record your answers to the following questions.

1. Which physical properties did you use to classify the buttons? *Answers will vary and may include that physical properties such as color, size, or shape were used to classify the buttons.*
2. How many groups did you make? *Answers will vary based on which physical property students used to classify the buttons.*
3. How many buttons were in each group? *Answers will vary based on the number and types of buttons students classified.*

Teacher Note

A shank is located on the back of some buttons. The shank has a hole in it for a button to be sewn to a piece of clothing.

Facilitation Questions

- Is there more than one way to classify the buttons? Why? *Yes, the buttons have many physical properties.*
- How did you classify the buttons? *Answers will vary and may include color, size, shank/no shank, number of holes, etc.*

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Unit 2: Matter and Energy

Student Pages

are embedded in all lessons for ease of use and include answers to student edition.

Science Notebook Icon

quickly indicates the need for students to use a science notebook.

Teacher Note

provides helpful tips and information.

Facilitation Questions

assist in guiding and scaffolding instruction.

UNIT 2: Matter and Energy

Lesson 1: Classifying Matter

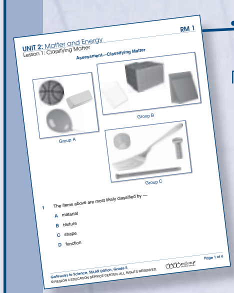
Materials

For each student
- RM 1

Evaluate

Teacher Instruction

- Instruct students to to complete *RM 1: Assessment—Classifying Matter.*



RM 1 Answer Key

1. A
2. J
3. A
4. G
5. D
6. G

Reproducible Master (RM) Snapshots and Answer Keys

offer an at-a-glance view. RM Answer Keys are placed in lesson to reduce the amount of printed materials.

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