Strategies for Science

Integrating Science

Science is everywhere. It is an integral part of each of our lives. From the time we turn off the alarm clock in the morning to when we watch the stars twinkle at night, there is science.

Physics, for example, teaches us how mirrors work, how glasses can aid one's vision, and how heat can provide a safe and clean environment in our homes. Chemistry discusses the principles of matter, like atoms, molecules, and compounds. These atoms, molecules, and compounds make up the water we drink, the food we eat, the air we breathe, and even the medicines that we take. Life science teaches us how all living things are categorized and why we need what we need to survive in our world.

In fact, the word science comes from a Greek word, "scientia," which means "knowledge." Science is a combination of process (how we learn about science) and content (the knowledge, concepts and understandings of science). So, teaching the concepts of science in our classrooms is an important part of a complete education – one needed by our students as they enter postsecondary education and the workplace.

Overview of Science Test

The 2014 GED® Science test assessment targets focus on three content domains:

- life science – approximately 40%
- physical science – approximately 40%
- Earth and space science – approximately 20%

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"Equipped with his five senses, man explores the universe around him and calls the adventure - Science."

Edwin Powell Hubble

Life science continues to be an integral part of the science test. This content area includes such topics as:

- Human body and health
- Relationship between life functions and energy intake
- Energy flow in ecologic networks (ecosystem)
- Organization of life
- Molecular basis for heredity
- Evolution

The area of physical science includes such content topics as:

- Conservation, transformation, and flow of energy
- Work, motion, and forces
- Chemical properties and reactions related to living systems

Earth and space science incorporates the world around us, from natural hazards to characteristics of our Earth to how our solar system impacts our world through tides and eclipses. Included are topic areas such as:

- Interactions between Earth's system and living things
- Earth and its system components and interactions
- Structures and organization of the cosmos

Within the Assessment Guide, subtopics are included to provide additional information on the types of content that could be assessed.

To provide an overall structure for the Science test, the key concepts assessed in science focus on two major themes:

- Human health and living systems
- Energy and related systems

These two themes have application across all domains of science and provide a way of linking the difference content areas assessed.

An Overview of the Connection Between Content Topics and Focusing Themes

		Science Content Topics		
		Life Science (40%)	**Physical Science (40%)**	**Earth & Space Science (20%)**
Focusing Themes	***Human Health and Living Systems***	• Human body and health • Organization of life • Molecular basis for heredity • Evolution	• Chemical properties and reactions related to human systems	• Interactions between Earth's systems and living things
	Energy and Related Systems	• Relationships between life functions and energy intake • Energy flows in ecologic networks (ecosystems)	• Conservation, transformation, and flow of energy • Work, motion, and forces	• Earth and its system components • Structure and organization of the cosmos

Not only is each item aligned to a science content area and a crosscutting theme, but each item on the Science Test is also aligned to a science practice.

Science practices are those skills that are necessary to scientific reasoning, sometimes referred to as inquiry. The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world. The term practices is used to emphasize that engaging in scientific investigation requires not only skills, but also knowledge that is specific to each practice.

The basic scientific practices that are assessed on the 2014 GED® test include:

- Comprehending scientific presentation
- Designing investigations
- Reasoning from data
- Evaluating conclusions with evidence
- Working with findings
- Expressing scientific information
- Understanding and applying scientific theories
- Using probability and statistics in a science context

It's important to remember that the science content topics describe key concepts that are widely taught in a variety of high school-level courses and are relevant to the lives of GED® test-takers.

Integration of Skills, Concepts, and Tools

Just like in real-world situations, skills, concepts, and tools from other disciplines are integrated. When test-takers describe a data set statistically, they may need to first complete a series of mathematical calculations based on an equation or formula. Mathematical reasoning skills and the use of a calculator may be needed to solve a science problem. Therefore, the TI-30XS MultiView™ calculator is provided, as needed, on the GED® Science test.

Another area of integration is the use of two short answer (SA) items. Strategies for teaching students how to answer these types of inquiry questions is similar to the process taught for the extended response questions on both Reasoning through Language Arts and Social Studies tests.

Each short answer (SA) item is scored on a three-point scale. For some items, the three points are accumulated when the test-taker identifies or analyzes up to three specific details or correct answers. One point is provided for each "correct" response. Individual scoring guides are developed for each short answer question on the Science Test to ensure an accurate assessment of the writing samples.

Resources

For additional information on GED® course code numbers and curriculum frameworks, access the:

- Adult Education Curriculum Frameworks/GED® 2013-2014
  http://www.fldoe.org/workforce/dwdframe/ad_frame.asp

For additional information on the Science Test Assessment Targets, access the Assessment Guide for Educators, Chapter 2:

- GED Testing Service® website
  http://www.gedtestingservice.com/educators/assessment-guide-for-educators

For additional information on the rubric for the short answer responses on the Science Test, access the Assessment Guide for Educators, Chapter 3:

- GED Testing Service® website
  http://www.gedtestingservice.com/educators/assessment-guide-for-educators

For additional information on the Next Generation Science Standards, access:

- Next Generation Science Standards
  http://www.nextgenscience.org/

Strategies for the Classroom

Getting Started

As with the other tests of the 2014 GED® test, science requires that students use critical thinking and problem-solving skills, as well as inquiry. Making science real is the first step in Integrating science in the GED® preparatory classroom.

- Be *explicit* about how activities and content relate to the nature and process of science
- Model scientific behaviors, strategies, language
- Integrate questions, such as: "How do I use science?" "How do others use science?" "How do we know this?"
- Use photos, videos, graphics to teach concepts
- Provide time for hands-on science activities and discussion

So, what are some ways that you incorporate the teaching of science into your program? First identify the "Big Ideas" of science, including both content and practices. For these items, use hands-on demonstrations and experiments to help students "see" science concepts at work. Don't forget that the World Wide Web is a wonderful resource to provide students with real-world experiences in science. From science museums to following endangered species via webcams to researching the latest information on a topic of interest, it's important for students to connect to the science of everyday life.

Of course, don't forget graphic literacy. Have students conduct surveys and construct tables and graphs as well as interpreting those already created.

Just like in our workplaces and daily lives, sometimes there is not just "one answer" to a science-oriented problem. Provide students with a current problem, e.g., how to clean up oil spills in the gulf. Use open-ended questions within the classroom and have students share the evidence or rationale that was used to develop a reasonable answer.

Don't forget to integrate writing as a tool for reading comprehension and of course, don't forget the resources provided through the GED Testing Service® website. Develop questions for class discussion and teacher-created assessment tools that are of the same cognitive rigor as the 2014

GED® test. A good place to begin is a thorough review of the Assessment Guide and the Item Samplers.

Ideas to Teach Science Vocabulary

Understanding science requires understanding the basic concepts of science as well as the vocabulary that is frequently used in the areas of physics, chemistry, life science, and earth and space science.

Research shows that it is easier to learn vocabulary when it is linked to prior or background knowledge. This helps to reach all types of learners including kinesthetic and visual learners as well as auditory learners. Background knowledge is not only important for vocabulary learning, but also for overall comprehension of what is being read.

Understanding the diverse vocabulary of science is extremely important to the comprehension of scientific writings and text. Activate your students' knowledge of science terms by having them brainstorm words they know about each subject area or to use the words in a narrative chain. Some basic activities to get you started in teaching science vocabulary are provided.

Before and After Vocabulary Grids

Give each student a list of key words or science concepts with two blank columns. In the first column, the students write the meaning of each word/concept or what they guess the meaning is. As they come across the word/concept later during the lesson, students can revise their original definition. Discuss new words and concepts as a group.

Word/Concept	What I think it means	Revised definition

Analyzing Prefixes and Roots

Sixty percent of English words are formed of roots and prefixes. When students come across a common prefix and/or root form, write the word on a sheet of paper and generate more words, first from the prefix and then with the root. List them on the paper. Discuss the definitions and the relationship of the words to each other. Science is filled with words that use the same root form, such as acid, which then can be used to writing such words as acids, acidic, and acidity.

The Narrative Chain

A narrative chain requires that students link words in a list together into a sentence or paragraph. By using the words and associating them they create a firmer connection between the new words and those already stored in their memory.

Science Narrative Chain Example: Provide students with the words: temperatures, southern, glacier, earth, tropical, rainforest, jungle, ice cap, moderate

A sample narrative chain might be as follows:

Although some of the places on the earth experience moderate temperature changes throughout the year, there are also areas where the temperatures are quite drastic. In some of the southern regions, one might experience a tropical rainforest or jungle-like atmosphere which is very hot and humid. Some parts of the earth are very cold all year long and are composed of glaciers or ice caps.

Classroom Questioning

Questions are central to the understanding of scientific concepts. When asking questions:

- Ask clear specific questions. If students have to guess at what you are asking, they are likely to remain quiet and not engage in the thinking you are expecting.
- Use cueing vocabulary that is familiar to students. By using the vocabulary they are used to students can better answer the question.
- Ask follow up questions to get at students' real understandings. Asking a second question can reveal the difference between a student's accurate understanding and misconceptions.
- Remember "wait time." Provide at least five seconds of thinking time after a question and after a response. Students need time to think and organize their response. Waiting lets students know that you are serious about wanting an answer to your question.
- Create a climate that supports risk taking. Establish eye contact and withhold judgment. Let students know that there is not a single correct answer for some questions.
- Allow students to ask their own questions. This often will further develop a topic and let students know you are interested in their reasoning.
- Listen to the answer and ask clarification questions as needed.

The following chart provides sample questions for guiding scientific thinking in the GED® preparatory classroom.

Sample Questions for Guiding Scientific Thinking

Question Type	Sample Question Starters
Recalling	Who, what, when, where, how ____?
Comparing	How is _____ similar to/different from_____?
Identifying Attributes & Components	What are the characteristics/parts of _____?
Classifying	How might we organize _____ into categories?
Ordering	Arrange _____ into sequence according to _____.
Identifying Relationships & Patterns	Develop an outline/diagram/web of _____.
Representing	In what other ways might we show/illustrate _____?
Identifying Main Ideas	What is the key concept/issue in _____? Retell the main idea of _____ in your own words.
Identifying Errors	What is wrong with _____?
Inferring	What might we infer from _____? What conclusions might be drawn from _____?
Predicting	What might happen if _____?
Elaborating	What ideas/details can you add to _____? Give an example of _____. Summarizing Can you summarize _____?
Establishing Criteria	What criteria would you use to judge/evaluate _____?
Verifying	What evidence supports _____? How might we prove/confirm _____?

Visual/Graphic Literacy

Visual (sometimes referred to as graphic) literacy continues to be an integral part of various types of texts, as well as media. It's often said that one picture is worth a thousand words. Think for a moment about all of the different types of graphs and charts that are included in the sample GED® test items.

One strategy for improving visual literacy is QAR (Question and Answer Relationships). This strategy is often used to improve reading comprehension skills, but it can also be used in analyzing different visuals.

The Question-Answer Relationships framework was first developed by Taffy E. Raphael (1982, 1986). QAR helps students increase reading comprehension by recognizing different types of questions and understanding where the answers to those questions can be found. When adapting the framework to graphics, students analyze the visual and ask themselves questions about where to find specific information.

The types of questions asked through the QAR strategy can be divided into two broad categories: *In the Book* (text explicit) or *In My Head* (text implicit) types of questions. *In the Book* questions are generated directly from a reading selection or a graphic. These explicit questions fall into two subcategories: *Right There* questions found in one place in a selection and *Think and Search* questions built around cumulative information found throughout a document.

In My Head questions are created by the reader when confronting a text or graphic. These questions are not explicitly found in the reading; rather, these questions arise as the reader engages the selection's content through active thought, comparison, synthesis, analysis, and evaluation. These implicit questions fall into two subcategories: *Author and You* questions that the text provokes in the reader and *On My Own* questions arising from the reader's prior knowledge and experiences.

QAR has four types of questions that are either *In the Book* or *In Your Head* types of questions:

Right There
Right there questions will have answers in the text or graphic. Right there questions often begin with "Who is", "What is", "When is", "What kind of", "Name", or "List". These questions are answered by locating or recalling the information.

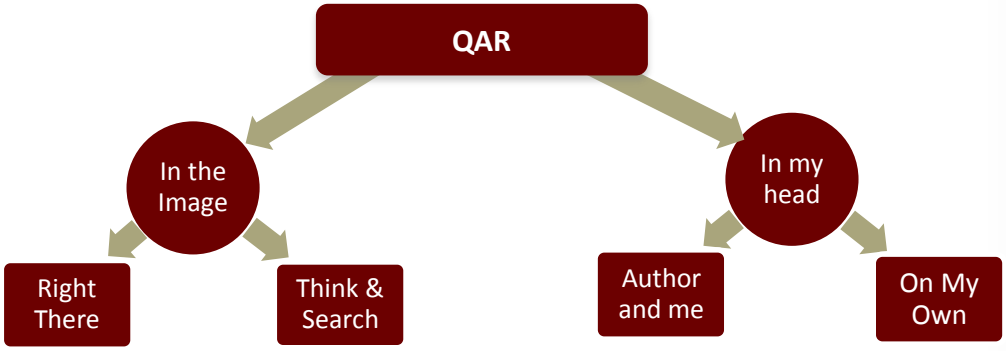
Think and Search
Think and search questions require reading several sentences or sections of text and/or graphics and combining the information together. These questions often begin with "Summarize", "What caused", "Contrast", "Compare", or "Explain". Students need to put information from several locations together in a way that is meaningful to answer the question.

Author and Me
Author and Me questions require that students answer with information beyond what is in the

text or graphic. The basic material to be elaborated on must be read and understood before students can add additional information to it. A typical question in chemistry might be "How could you tell if a substance is a metal or nonmetal?" The question assumes that students know the properties of metal and nonmetals and will be able to generate a lab test based on these properties.

On My Own

On my own questions require answers not in the text or graphic. These questions require that students use background knowledge to support their opinions. A typical On My Own question might be "How can plastics be most effectively designed to serve society rather than harm it?"



Summing It Up

To get started with integrating science into the GED® preparatory classroom,

- Incorporate small and large group session, focusing on science concepts and principles that will help students gain core knowledge they will need on the test and for life.
- Use the local newspaper or *USA Today* to provide students with an opportunity to interpret graphic-based material, including graphs, charts, maps, etc. The newspaper is an excellent resource for information related to the environment and health issues. Many newspapers include a health section. Use articles to discuss issues such as diet, exercise, disease prevention, medical advances, etc.
- Have students conduct surveys about environmental, health, or other science issues that affect their daily lives. Have the students construct graphs to report their results. If students understand when and why they should use line graphs versus bar graphs versus circle graphs, it will help them interpret the graphs included on the test.
- Use weather maps in the local newspaper to track weather trends and changes. Have students make predictions based on the information provided on the maps.
- Use the Internet to expose students to new material. Capture their interest through the exploration of websites that focus on various aspects of science.

- Provide opportunities for students to solve real-world science problems, such as how to best clean up an oil spill.
- Use experiments (hands-on activities) for students to predict or hypothesize about an answer and then to complete the scientific process to determine a correct hypothesis or the need for changing their initial prediction.

Resources

Although there are numerous resources to assist the classroom instructor, the following are a few websites to start with:

- **Cells Alive**
  http://www.cellsalive.com/toc.htm

- **Discovery Channel**
  http://dsc.discovery.com/

- **Exploratorium Online**
  http://www.exploratorium.edu/

- **Franklin Institute**
  http://www2.fi.edu/

- **How Stuff Works**
  http://science.howstuffworks.com/

- **Newton's Apple**
  http://www.tpt.org/newtons/

- **PBS: Science & Nature**
  http://www.pbs.org/topics/science-nature/