Scientific Minds Want to Know: Strategies for Addressing Most-Missed Areas in the GED® Science Test

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Webinar Guide
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GEDTS Analysis – Most Missed Items Related to Science

- ✓ Pull specific evidence from a written source to support a finding or conclusion
- ✓ Express scientific information or findings in words
- ✓ Understand and apply scientific models, theories, and processes

Science Practices

- ✓ Evaluating conclusion with evidence
- ✓ Working with findings
- ✓ Expressing scientific information
- ✓ Scientific theories

Breaking It Down – Analyzing Science Text

Analyze the text. Which words or details support your conclusion?

1 Passage from the text	
Your analysis or conclusion	
Evidence and details that support or disprove your conclusion	
2 Passage from the text	
Your analysis or conclusion	
Evidence and details that support or disprove your conclusion	

How Do You Know?

Citing Textual Evidence in Writing

- In the text/article/passage/report, . . .
- The author states that . . .
- According to the text/article/passage/report, . . .
- In addition, the author also writes . . .
- The text also cites . . .
- On page/paragraph . . ., it states that . . .
- An example is . . .
- The graphic/photograph/chart/table shows that . . .
- . . . This proves . . .
- . . . This demonstrates . . .

Evaluating the Evidence

After reading the passage, determine if the evidence and/or reasoning support the author's claim to solve a problem.

Claim	
Evidence and/or reasoning	
Does the evidence/reasoning support the claim? Why or why not?	

Examining the Evidence

When reading, examine the reasoning used to support the claim and solution. Answer the following questions as you critically read the text.

What is the claim or solution?	
How did the expert determine the accuracy and effectiveness of this solution?	
Is the reasoning sound? Does it make sense?	
Is the evidence credible and convincing?	

Question and Answer Relationships – QAR

QAR is a reading technique, whose acronym stands for Question and Answer Relationships. Incorporating QAR can assist students in better comprehending text or graphics and using that information to correctly answer questions.

Right There	**Author and You**
The answer is in the text or graphic. The answer is usually easy to find. (You can put your finger on the page and point to the answer.) The words used to make up the question and **the words or numbers used to answer the question are Right There**.	The answer is not in the text pr graphic. You can use the information you **already know** about the topic **AND** Any information the **author has provided in the paragraph or graphic** to answer the question. Use your knowledge and the author's information to answer the question.
Think and Search	**On Your Own**
The answer is in the text or graphic; however, you must **put together different information** to reach the answer. The words in the question and the **words or numbers needed to answer the question are not the same.** **Think and Search** different sections or elements of the text or graphic to answer the question. More than one text or graphic may need to be consulted.	The answer is **not in the text or graphic**. Using the information you **already know about the topic or based upon your experience,** you can answer the question. **HOWEVER** Reading the text or graphic will usually expand your knowledge and will help you give a specific or clearer answer to the question.

Adapted from Raphael, T. (1986). Teaching Question-Answer Relationships, Revised. *The Reading Teacher*. 39, 516-522 and Mesmer, H. A. E., & Hutchins, E. J. (2002). Using QARS with Charts and Graphs. *The Reading Teacher*, 56, 21-27.

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 and Components	What are the characteristics/parts of _____?
Classifying	How might we organize _____ into categories?
Ordering	Arrange _____ into sequence according to _____.
Identifying Relationships and 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 _____?

Text Dependent Question Types - Science

Text Dependent Question Types: Science

Below are nine different question types that map the domain of possible text dependent questions and model the kinds of information a close reading of the text should uncover.

"Right There" Questions

Ask for explicit information drawn from the text itself: "Identify the different concerns of physical geology versus historical geology." "According to the article, what is a fossil?"

Text Structure Questions

Look at how the text and its component parts are arranged: "What is the relationship between the opening paragraph and the next two?" "How does the opening sentence of the paragraph on historical geology hint at its various branches of study?"

Sequence Questions

Identify and analyze the steps in an explanation or argument: "What branches of historical geology does the author weave together to tell a story about the Earth's history? How does she use transitional language in that paragraph to connect her ideas?"

Clarification Questions

Ask for further explanation of particular portions of the text: "Why did the author include the anecdote about the Grand Canyon? What is it meant to illustrate?" "How do fossils reflect two different aspects of physical geology?"

Paraphrasing Questions

Request condensed summaries of particular passages: "Paraphrase the explanation given of the different branches of physical geology." "Compare and contrast the activities of physical versus historical geologists."

"Geology"
U*X*L Encyclopedia of Science

Geology is the scientific study of Earth. Geologists study the planet — its formation, its internal structure, its materials, its chemical and physical processes, and its history. Mountains, valleys, plains, sea floors, minerals, rocks, fossils, and the processes that create and destroy each of these are all the domain of the geologist. Geology is divided into two broad categories of study: physical geology and historical geology.

Physical geology is concerned with the processes occurring on or below the surface of Earth and the materials on which they operate. These processes include volcanic eruptions, landslides, earthquakes, and floods. Materials include rocks, air, seawater, soils, and sediment. Physical geology further divides into more specific branches, each of which deals with its own part of Earth's materials, landforms, and processes. Mineralogy and petrology investigate the composition and origin of minerals and rocks. Volcanologists study lava, rocks, and gases on live, dormant, and extinct volcanoes. Seismologists use instruments to monitor and predict earthquakes and volcanic eruptions.

Historical geology is concerned with the chronology of events, both physical and biological, that have taken place in Earth's history. Paleontologists study fossils (remains of ancient life) for evidence of the evolution of life on Earth. Fossils not only relate evolution, but also speak of the environment in which the organism lived. Corals in rocks at the top of the Grand Canyon in Arizona, for example, show a shallow sea flooded the area around 290 million years ago. In addition, by determining the ages and types of rocks around the world, geologists piece together continental and oceanic history over the past few billion years. Plate tectonics (the study of the movement of the sections of Earth's crust) adds to Earth's story with details of the changing configuration of the continents and oceans.

Inferential Questions

Solicit conclusions that stem from evidence within the text but not explicitly stated: "Based on the description, what branches of geology can be inferred to exist even though they are not mentioned?" "What is the chronological boundary between the two categories of geology (e.g. when does historical geology end and physical geology begin?)"

Organizing Questions

Examine the text and sort information based on relevant criteria: "List the different branches of study in one category of geology and the kind of geoloist associated with each." "Earthquakes are caused by shifts in the Earth's tectonic plates. What branch or branches of geology would investigate these events?"

Academic Vocabulary & Key Phrases Questions

Focus on how specific word choices contribute to the meaning of the text: "Based on the context of the sentence, what is the meaning of the word *dormant*?" "How does the meaning of the word *configuration* factor into the description of plate tectonics?" "What words and phrases from the article help the reader understand the meaning of *domain*?"

Purpose Questions

Investigate the text's function and deeper meaning: "What ideas from the article can be used to explain the purpose of the study of geology." "Geologists study the past, present, and even the future of the planet. What conclusions can be drawn about the specifica activities of geologists?"

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Lesson Title: Scientific Inquiry: Which Falls Fastest?

Objectives and Standards
Students will:

- Identify the steps of the scientific inquiry method
- Conduct a physics experiment
- Recognize and understand basic concepts of laws of motion

Materials

- Calculators
- *Scientific Inquiry - Which Falls Fastest?* Activity Sheet
- Sheets of paper

Instructional Plan

Overview
In this lesson, students will become familiar with the scientific inquiry method by conducting a simple physics experiment. A step-by-step format is provided to ensure that students explore the process.

Process
Begin the lesson by asking students how science is important in their daily lives. Discuss that a major goal of science is to investigate and understand the natural world, to explain events in the natural world, and to use those explanations to make useful predictions. Share with students that they will be taking the role of scientists today as they observe a simple phenomenon of physics.

Review with students the basic terms of inquiry: quantitative data, qualitative data, observation, hypothesis, controlled experiment, controlled variables, and uncontrolled variables.

Divide the class into small groups of three to four students. Provide each group with the *Scientific Inquiry - Which Falls Fastest?* Activity Sheet. Review the expectations of the activity with the class. Share with students that they should follow each step carefully as they create their hypothesis and then test whether or not they were correct.

Debrief the activity by having students share their results with the class. As a class, identify whether other shapes were more aero dynamic and fell more quickly than those indicated on the sheet.

Sample Debriefing Questions
Have students answer the following questions regarding their experiment:

- Which paper shape fell fastest? Slowest? Why?
- What types of shapes did you also use to view similarities and differences in falling rate? Which were slower? Faster? Why?

- Would weight impact whether or not an item fell faster or slower? Example: What would happen if you dropped an orange and a grape from the same height at the same time? Why?
- What variables impact the speed of a falling object? Why?
- What law(s) of physics were you able to prove or disprove through your experiment?

Assessments/Extensions

Have students use the scientific inquiry method to prove or disprove hypothesis through creating different types of experiments. Make sure that students complete a science inquiry sheet as they observe, form a hypothesis, conduct an experiment, and then determine the accuracy of their prediction. A sample Science Inquiry Form is located at the end of this lesson.
Sample experiments and videos of experiments can be found via a search of the World Wide Web. Sites to start your exploration for experiments to use in the classroom are:

- **Newton's Apple.** NEWTON'S APPLE is a production of Twin Cities Public Television from a grant from the 3M Foundation. The site is filled with free videos for use in many different areas. http://www.newtonsapple.tv/
- **Steve Spangler.** This site has lots of free experiments and videos for use in the classroom. http://www.stevespanglerscience.com/lab
- **Edible/Inedible Experiments.** Lots of experiments which are easy to use in any type of classroom. http://www.madsci.org/experiments/
- **Home Experiments.** The name says it all as most products for these experiments are found in one's home. http://scifun.chem.wisc.edu/HOMEEXPTS/HOMEEXPTS.HTML
- **TryScience/New York Hall of Science.** Experiments online and with directions. Fun activities for all types of science. http://www.tryscience.org/

Scientific Inquiry – Which Falls Fastest?

Which shape of paper falls fastest: An unfolded sheet of paper, a paper folded in fourths, or a sheet of crumpled paper? Or can you create a different shape with paper that falls even faster?

Make Your Plan:

What is your independent (manipulated variable)?	
What is your dependent (responding) variable	
What is your question?	
What is your hypothesis?	If, then . . .
What are the constants? (name at least 3)	

Data:

Identify your dependent and independent variables for each trial.

- Independent variables are the variables that are changed in a given model or equation. One can also think of them as the 'input' which is then modified by the model to change the 'output' or dependent variable.
- Dependent variables are considered to be functions of the independent variables, changing only as the independent variable changes.

Dependent Variables

_____

Independent Variables

_____

	Unfolded paper	Paper in Fourths	Crumpled Paper	Unique Shape
Trial 1				
Trial 2				
Trial 3				
Trial 4				
Average				

Calculations: Show work below:

Average for _____ paper:
_____ + _____ + _____ + _____ = _____÷ 4 =
Average for _____ paper:
_____ + _____ + _____ + _____ = _____÷ 4 =
Average for _____ paper:
_____ + _____ + _____ + _____ = _____÷ 4 =
Average for _____ paper:
_____ + _____ + _____ + _____ = _____÷ 4 =

Find your largest difference:
_____ paper fell in the slowest average time which was _____s.

_____ paper fell in the fastest average time which was _____s.

The difference between these two number (use subtraction) is =_____s

Is this Qualitative or Quantitative Data? Why?

Conclusion:

Based on the data from my experiment, I reject or accept the hypothesis that (Restate your hypothesis WORD FOR WORD)

_____

_____

_____.

The evidence to support this is that the average time for an unfolded piece of paper was _____ s, for a sheet folded in fourths was _____s, and a crumpled sheet of paper was _____s. The difference between the _____ piece of paper and _____ piece of paper was _____s. This difference does or does not seem significant to me. Therefore, I conclude that _____ paper _____.

Inquiry Method Recording Sheet

Step 1 – Observations, Questions, and Hypotheses	
Observations	Questions
Hypothesis If . . . Then . . .	
Step 2 – Scientific Testing	
Investigation & Data	
Step 3 – Analysis and Conclusion	
Discuss data & draw conclusion	
Step 4 - Communication	
We communicated our results by	

Science Lesson Planning Strategies – The 5 Es

The 5E Instructional Model provides a format for lessons that builds on what students already know. The 5Es sequence the learning experience so that the learners construct their understanding of a concept across time. Each phase of the learning sequence can be described using five words that begin with "E": *engage, explore, explain, extend,* and *evaluate*.

Engage
Begin each unit or topic with a lesson or activity that engages students with an activity or question as they are introduced to the concept. Students should make connections to prior knowledge and what is to be studied. During this phase, teachers ask questions of students and engage them in the guided inquiry lessons. They use strategies such as KWL or ABC Brainstorm that make connections between the past and present learning experience.

Explore
Have students carry out hands-on activities in which they explore the concept or skill. This phase allows students to acquire a common set of experiences that they can use to help each other make sense of the new concept or skill. Teachers should set up the investigation and guide students in inquiry, asking probing questions to clarify understanding.

Explain
After students have explored the concept or skill, the teacher provides the concepts and terms used by the students to develop explanations for the phenomenon they have experienced. The significant aspect of this phase is that explanation follows experience. Teachers should ask probing questions that encourage students to look for additional information.

Elaborate
Students expand their learning, practice skills and behavior, and make connections or applications to related concepts and in the world around them. Teachers provide learning opportunities for students to apply their knowledge and to gain a deeper understanding. Activities can include reading articles and books, writing, designing other experiments, and exploring related topics on the Internet. Provide opportunities for students to apply what they have learned to new situations. It is important for students to discuss and compare their ideas with each other during this phase.

Evaluate
The final phase provides an opportunity for students to review and reflect on their own learning and new understandings and skills. This is the phase where students provide evidence for changes to their understandings, beliefs, and skills. Teachers should assess students understanding through both formative and summative activities.

An Overview of the 5Es		
Phase	**Purpose**	**Role of Teacher**
Engage	Create interest and stimulate curiosity. Set learning within a meaningful context. Raise questions for inquiry. Reveal students' ideas and beliefs, compare students' ideas.	Activity or multi-modal text used to set context and establish topicality and relevance. Motivating/discrepant experience to create interest and raise questions. Open questions, individual student writing, drawing, acting out understandings, and discussion to reveal students' existing ideas and beliefs so that teachers are aware of current conceptions and can plan to extend and challenge as appropriate – a form of diagnostic assessment.
Explore	Provide experience of the phenomenon or concept. Explore and inquire into students' questions and test their ideas. Investigate and solve problems.	Open investigations to experience the phenomenon, collect evidence through observation and measurement, test ideas and try to answer questions. Investigation of text-based materials (e.g. newspaper articles, web-based articles) with consideration given to aspects of critical literacy, including making judgments about the reliability of the sources or the scientific claims made in the texts.
Explain	Introduce conceptual tools that can be used to interpret the evidence and construct explanations of the phenomenon. Construct multi-modal explanations and justify claims in terms of the evidence gathered. Compare explanations generated by different students/groups.	Student reading or teacher explanation to access concepts and terms that will be useful in interpreting evidence and explaining the phenomenon. Small group discussion to generate explanations, compare ideas and relate evidence to explanations. Individual writing, drawing and mapping to clarify ideas and explanations. Formative assessment to provide feedback to teacher and students about development of investigation skills and conceptual understandings. Small group writing/design to generate a communication product (e.g. poster, oral report, formal written report or PowerPoint presentation, cartoon strip, drama presentation, letter) with attention to form of argumentation, genre form/function and audience, and with integration of different modes for representing science ideas and findings.
Elaborate	Use and apply concepts and explanations in new contexts to test their general applicability. Reconstruct and extend explanations and understandings using and integrating different modes, such as written language, diagrammatic	Further investigations, exercises, problems or design tasks to provide an opportunity to apply, clarify, extend and consolidate new conceptual understandings and skills. Further reading, individual and group writing may be used to introduce additional concepts and clarify meanings through writing. A communication product may be produced to re-represent ideas using and integrating diverse representational modes and genres consolidating

	and graphic modes, and mathematics.	and extending science understandings and literacy practices.
Evaluate	Provide an opportunity for students to review and reflect on their own learning and new understandings and skills. Provide evidence for changes to students' understandings, beliefs and skills.	Discussion of open questions or writing and diagrammatic responses to open questions – may use same/similar questions to those used in Engage phase to generate additional evidence of the extent to which the learning outcomes have been achieved. Reflections on changes to explanations generated in Engage and Evaluation phases to help students be more metacognitively aware of their learning.

Planning with the 5 Es

Topic: _____

Engage (introduce with excitement)	
Explore (meaning of the concept)	
Explain (how the concept applies, an investigation)	
Elaborate (on the meaning or application of concept)	
Evaluate (student's level of understanding)	

Putting It All Together: Reading Nonfiction Text

Identify the main or central idea	
Summarize the main idea in your own words	
Provide supporting details	
How does this connect to previous learning?	
How is the text organized?	
How does this organization of the text help you understand it?	
What is the author's purpose?	

Is the author credible? How do you know?	
How does the author validate his/her claim?	
Is the evidence convincing? Why or why not?	
Try to challenge this information using facts and/or reliable sources.	

Four Reads for Primary Sources

#1 – Read for Origins and Context • Read top of document (title, author, place, date) • Read bottom of document (bibliographic info, notes, etc.) • Do not read the main body of the document	**#2 – Reading for Meaning** • Read through the main body • Identify the central idea • Skip any difficult or confusing sections • Underline the sentence or phrase that captures the author's central idea

#3 – Read for Argument
• Read the main body again
• Underline any support for argument (assertions, evidence)
• Make notes and answer questions
  ○ Is support strong?
  ○ Is it logical and believable?
  ○ Does it contradict other evidence?
	#4 – Read Like a Scientist
	• Connect #1 with main body
	• Answer key questions
	  ○ What is the author's perspective or bias?
	  ○ How does that impact the argument?
	  ○ How is argument shaped to audience and place?
	  ○ What is the larger argument of the document? Is it convincing?
	  ○ What questions are unanswered?

Online Resources for Science

ABC Science. News, video clips, games, and lots of activities for the science classroom from the American Broadcasting Company. http://www.abc.net.au/science/

Annenberg: The Habitable Planet. The Habitable Planet is a multimedia course for high school teachers and adult learners interested in studying environmental science. The Web site provides access to course content and activities developed by leading scientists and researchers in the field. http://www.learner.org/channel/courses/envsci/index.html

Annenberg Science in Focus: Force and Motion. Explore science concepts in force and motion and come away with a deeper understanding that will help you engage your students in their own explorations. With science and education experts as your guides, learn more about gravity, friction, air resistance, magnetism, and tension through activities, discussions, and demonstrations. http://www.learner.org/channel/workshops/force/

BBC Science. From space to the human body to, this interactive site allows learners to discover many different facets of science. http://www.bbc.co.uk/sn/

Cells Alive. This site can be used by teachers and students. Lots of great interactivity and resources on the basics of cells. http://www.cellsalive.com/toc.htm

Discovery Channel. The website has lots more information than even the channel. Lots of interactivity with excellent videos, interactivity, and high-level games. http://www.discovery.com/

Edheads. An organization that provides engaging web simulations and activities. Current activities focus on simulated surgical procedures, cell phone design (with market research), simple and compound machines, and weather prediction. http://edheads.org/

Exploratorium Online. Since 1993, the Exploratorium was one of the first science museums to build a site on the World Wide Web. The site contains over 15,000 articles and displays including interactivity regarding science. http://www.exploratorium.edu/

Franklin Institute. Excellent collection of online resources and activities designed to create curiosity and promote science in everyday life. http://www.fi.edu/explore.html

How Stuff Works. Ever wondered why a cd works? How about the ten myths about the brain? How about what would happen if you put sugar in your gas tank? An interesting science site filled with real-world information. http://www.howstuffworks.com/

Interactive Websites for Teaching Science. Just click on one of the topics and explore the myriad of resources on the World Wide Web. http://interactivesites.weebly.com/science.html

Live Science. Articles from the headlines in all of the various areas of science. Great non-fiction materials. http://www.livescience.com/

National Science Teachers Association. Don't forget the professional organization for science teachers. This site has lots of ideas, lessons, and scientific updates.
http://www.nsta.org/

NEWSELA. This website is an innovative way to build reading comprehension with nonfiction through daily news articles..https://newsela.com/

Newton's Apple. NEWTON'S APPLE is a production of Twin Cities Public Television from a grant from the 3M Foundation. The site is filled with free videos for use in many different areas. http://www.newtonsapple.tv/

Nye Labs.com This is indeed "Bill Nye, the science guy" with lots of activities and applications for science. http://www.billnye.com

PBS: Science & Nature. Highlights and background information on every Science-based PBS program on the air; check out the Science for the Classroom link. http://www.pbs.org/science/

Steve Spangler. This site has lots of free experiments and videos for use in the classroom. http://www.stevespanglerscience.com/lab

The Why Files. University of Wisconsin, Board of Regents. Real world articles to support all areas of science. Click on the "Why Files in Education." http://whyfiles.org/teach/

Understanding Science. The Understanding Science website is a fun, free resource that aims to accurately communicate what science is and how it really works. It provides "an inside look at the general principles, methods, and motivations that underlie all of science." http://undsci.berkeley.edu/

Weather Classroom. The Weather Classroom presents all kinds of online interactive resources for students and teachers; worth investigating. http://www.weatherclassroom.com/index.php