GED® Science: 5Es for Effective Instruction

Tools for the Classroom

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5 Es for Effective Instruction

GED® Science

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Science High Impact Indicators

Indicator	What to look for in student work: Students' work shows they have . . .
SP.2.b: Identify and refine hypotheses for scientific investigations.	• identified a hypothesis for a given scientific investigation. • differentiated between an appropriate hypothesis and a poorly conceived hypothesis. • used a hypothesis to support or challenge a given conclusion. • identified a hypothesis for a given data set. • refined a hypothesis to more appropriately suit a scientific experiment.
SP.2.e: Identify and interpret independent and dependent variables in scientific investigations.	• identified the independent variable in a given investigation. • identified the dependent variable in a given investigation. • fully explained the relationship between the independent and dependent variables in a given experiment.
SP.4.a: Evaluate whether a conclusion or theory is supported or challenged by particular data or evidence.	• identified and explained why the evidence supports the proposed claim or solution. • identified and explained which piece of data supports or contradicts the given hypothesis. • identified multiple reasons a piece of evidence supports a theory or hypothesis and compare those reasons to each other. • identified which scientific model would be weakened or strengthen by particular evidence. • fully explained why given evidence supports a scientific theory. • fully explained why given evidence challenges a scientific theory.
SP.6.a: Express scientific information or findings visually.	• translated information presented verbally or numerically into a visual format • integrated information presented verbally and numerically into a visual format • identified relationships among graphs or diagrams • identified visual representations of scientific processes explained in a given text • completed diagrams to demonstrate understanding of relationships among variables, scientific concepts, or processes
SP.7: Apply formulas from scientific theories.	• solved for a variable within a scientific equation • balanced an equation. • identified what changes will result if a variable within a scientific equation increases or decreases. • identified relationships between variables in a scientific formula. • interpreted symbolic representations of information and scientific data.

Scientific 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, transformatio n, and flow of energy • Work, motion, and forces	• Earth and its system components • Structure and organization of the cosmos

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 (extend)
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 (extend)	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 and graphic modes, and mathematics.	• 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 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.

Using the 5Es to Encourage Discussion

Explore

- What do you think will happen?
- Why? How?
- What other materials do you think you will need?
- What do you want to learn from this exploration?
- How are you going to document your findings/results?
- What do you feel is important to research and report out to teach others?

Explain

- How do you think _____ connects with this exploration?
- Why do you think _____ happened?
- How can we connect the reading/video/movie with what we did in the exploration?

Elaborate/Extend

- How will this impact the real world?
- What do you notice about your data?
- Does this look/sound familiar to something you have seen before?
- Did you change your thinking or add to your thinking during this investigation?
- What evidence do you have to support your thinking?
- What further research would you need to do?
- What could you create to help solve the problem?

Evaluate

- What were your conclusions?
- Are they valid and reliable? How do you know?
- In further explorations, what do you want to keep in mind?
- Have your thoughts changed about _____ from when we started? Look back in your notebook for ways your thinking grew.
- What have you learned about_____? What proof do you have to support what you've learned about it?

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)	

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 _____.

Resources from the World Wide Web

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/

ACS Chemistry for Life. Chemistry lesson plans using the 5 Es.
http://www.middleschoolchemistry.com/lessonplans/

Annenberg: The Habitable Planet. The Habitable Planet is a multimedia course for high school teachers and adult learners interested in studying environmental science.
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.
http://www.learner.org/channel/workshops/force/

Discovery Education. The website provides lesson plans on earth and space science. http://www.discoveryeducation.com/search/page/-/-/lesson-plan/earth%20science/index.cfm

Environmental Protection Agency. Lesson plans on the various topics regarding the environment from the EPA. http://www.epa.gov/students/lesson-plans-teacher-guides-and-online-resources-educators

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/

Ted Ed Lessons. This website has great videos and lesson plans in all areas of science. http://ed.ted.com/lessons

Teachers Try Science. This site provides free and engaging **lessons**, along with **teaching strategies and resources**, which are designed to spark students' interest in science, technology, engineering and math.
http://www.tryscience.org/