Part VI. Gateway Instructional Strategies for Science

This section contains the following instructional strategies:

- Preparing Students for the Gateway Assessment
  - Types of Questions
  - Understanding the Assigned Task
  - Writing an Effective Gateway Essay
- Using the Gateway Anchor Papers in the Classroom
- Conducting a Practice Gateway Assessment
- Writing to Learn
Preparing Students for the Gateway Assessment

The Gateway Assessment tests a student’s ability to integrate information from a variety of scientific sources and to communicate effectively in a timed writing context. These abilities require practice and are most appropriately taught on an interdisciplinary basis throughout the school year. Adequate test preparation cannot be achieved with a last minute course in “How to Take the Gateway.” Students need repeated exposure to the expectations for writing effectively in the content area of science. Many general skills in writing apply to scientific writing, but there are also conventions specific to scientific writing that require explicit instruction. Regular writing assignments about science content are the most effective preparation for the Gateway Assessment, and these will also help students learn the facts, concepts, and principles in the AKS. The following are some suggestions for preparing students for the Gateway assessment:

WHAT TYPES OF QUESTIONS ARE ON THE GATEWAY ASSESSMENT FOR SCIENCE?

Students will be expected to answer questions about the following topics in biology and chemistry:

- Biological systems in organisms
- Life functions in organisms
- Energy transfer in ecosystems
- Solubility
- Nutrition
- Energy transformation
- Causes of ecological changes
- Factors that affect population growth
- Genetics

UNDERSTANDING THE ASSIGNED TASK

Review the Vocabulary Used in the Gateway Assigned Writing Tasks

- Familiarize students with the verbs used in science essay test questions:
  - Explain
  - Identify
  - Describe
  - Interpret
  - Analyze
  - Compare
  - Contrast
  - State
- Define
- Relate
- Propose and support
- Discuss
- Construct

- Students may be familiar with most of these terms from other reading or writing contexts, but many students will still require explicit instruction on applying these terms in the context of science writing.

- One of the bullets for the Cycling of Matter Gateway topic asks the students to “Describe how carbon is cycled between living organisms and their environments.” Regardless of which of the verbs listed above is used in the assigned Gateway task, students are expected to provide a fully elaborated explanation in their responses. All explanations in Gateway responses should include explicit reasoning and specific, relevant examples.

**Understanding and Using the Information in the Gateway Documents**

- Students need explicit instruction in processing scientific documents like diagrams, tables, charts, and formulas in order to be prepared for the Gateway Assessment. Students taking the Gateway will also be expected to construct graphs from data provided in tables. It is important to assess your students’ ability to interpret and construct scientific documents at the beginning of the school year in order to plan for their instructional needs. These scientific skills are a form of visual literacy that is often overlooked in general reading comprehension course work, because most non-science books don’t contain diagrams, data tables, and graphs.

- Review the use of decimals in scientific data, particularly with values of decimals lower than 1. Students taking the Gateway are often confused about the relative sizes of decimal values such as .001, .332, and .123. This confusion results in incorrect graphs and incorrect explanations of scientific data.

- Review the meanings of arrows in diagrams and formulas. Research in visual literacy indicates that arrows in scientific diagrams can have up to six different meanings (Schollum as cited in McTigue and Flowers, 2011).
  - Representation of force
  - Showing change
  - Indicating sequence
  - Labeling
  - Measuring
  - Showing relationships
• Practice analyzing the scientific diagrams in the biology and/or chemistry textbook as a whole class activity or with struggling readers and writers.

• Practice constructing graphs from data tables. This skill may constitute the majority of the student’s score in some assigned tasks. Students often demonstrate confusion over how to label the axes of a graph and how to draw a best fit line in their Gateway responses. Students are also expected to interpret the lines that are plotted on the graphs when taking Gateway.

WRITING AN EFFECTIVE GATEWAY ESSAY

Planning the Essay

• Post the High School Gateway Writing Checklist in the classroom. This will be the only writing resource that students have available to them during the Gateway Assessment. The writing checklist provides reminders of the expectations for each scoring domain of Gateway.

• Show students the Gateway response folder and discuss the time allotted for planning and drafting during the Gateway Assessment.

• Provide students with prewriting strategies for developing an appropriate overall plan during a timed science writing assessment. The quality of each student’s overall plan is scored in Organization of Scientific Concepts.
  o Outlining can serve as both a note-taking skill as well as a prewriting strategy for the Gateway Assessment.
  o Constructing a concept map of the topic can serve as a prewriting strategy and a learning strategy:
    ▪ Providing a grouping and sequencing basis for the writer’s overall plan.
    ▪ Revealing the links between the writer’s major ideas.
    ▪ Providing additional cues to the writer’s prior knowledge.
    ▪ The completed concept map can also serve as a study guide for classroom assessments and the Gateway Assessment.
    ▪ A classroom notebook of concept maps (student or teacher created) for each science unit covered during the year can also serve as a review for the Gateway Assessment.

• Effective writers often plan the introduction and conclusion to a piece of writing after the plan for the body of the essay has been decided and drafted. This allows the writer to first see an overview of his or her major ideas and then choose the most appropriate method to introduce the reader to the topic and purpose of the essay.
• Students need to be reminded that effective conclusions do not merely repeat what has been written in the body of the response, and that there are many types of introductions and conclusions that are appropriate for scientific writing.

• After prewriting, students should review the assigned task once again to ensure that their writing plans cover each part of the assigned task. Students should also check the time remaining for the assessment.

• Make sure students understand the importance of including relevant prior knowledge throughout their responses in addition to relevant information in the provided documents.

Drafting the Essay
• Remind students that every claim a writer makes in scientific writing must be substantiated with relevant, scientific evidence (facts). Although the Gateway is not an assessment of persuasive writing, students are expected to offer scientific proof for every statement they make. This requires demonstrating an understanding of relevant facts as well as why and how scientific processes occur, not merely listing what occurs.

• As a class activity, read some of the responses in the guide that received scores of “5” in Development and Knowledge. Ask students to articulate in their own words the qualities of a fully (or sufficiently) elaborated Gateway response.

Using Scientific Vocabulary on the Gateway Assessment for Science
• Teach students to translate between generic, everyday language and precise scientific vocabulary.
  o Student responses in the Assessment and Instructional Guide can serve as anonymous classroom models of “what to do” or “what not to do” in scientific writing.

• Remind students to use precise scientific vocabulary throughout their Gateway responses and in classroom assignments during the year.
  o Advise students to avoid generic words (something, stuff), slang, and texting abbreviations (b/c).
  o A misspelled but precise scientific term is a less severe error than a very simple or general word spelled correctly.

• Students may use the vocabulary words from any part of the assigned writing task in their responses, but it is not appropriate to copy entire phrases and sentences verbatim from the test pamphlet without using quotation marks and a citation of the source.
• Instruct students in the proper citation of sources by reviewing “Citing Original Sources” in this guide.

Development and Elaboration in Scientific Writing

• Allow students to discuss the amount of elaboration used at each level in the released writing samples.

• Students need to know how much and what types of elaboration constitute an effective response to a Gateway task. The following are the types of ideas that should be included in each part of a response to a Gateway task:
  o Definitions of scientific terminology
    ▪ For the Cycling of Matter topic, these might include definitions of Food webs, producers, consumers, and decomposers.
  o Step-by-step specific explanations of scientific processes related to the task.
    ▪ For the Law of Conservation of Matter and Energy, these could include explanations of how photosynthesis and cellular respiration occur.
  o Connections and detailed explanations of connections between parts of the assigned task.
    ▪ For Cycling of Matter, these could include how photosynthesis and cellular respiration are connected to the carbon cycle and food webs.
  o Specific examples of scientific evidence (facts) that support the writer’s reasoning.
    ▪ For photosynthesis, an explanation of balanced equations might include facts about how many molecules of carbon occur in the reactants and the products of photosynthesis.
    ▪ Even when the writer is specifically asked to “describe” in the assigned task, the underlying expectation is that the writer will “explain” both how and why a process occurs and provide evidence to support the explanation.
  o Specific scientific data from the provided documents if applicable.

• Students need opportunities to practice making scientific connections. There are many connections embedded in biological and chemical processes:
  o Connections to the everyday world.
  o Connections between biology and chemistry.
  o Connections between facts and concepts related to the topic: “Rain falls from the sky in a faraway savannah, a lion chases down an antelope in an urban factory, coal is burned to power an industrial machine. What do all these situations have in common? They are all various stages of the cycling of matter.”
  o Connections between concepts and principles related to the topic.
- Connections between principles embedded in the assigned task and larger scientific laws and principles.

**USING THE GATEWAY ANCHOR PAPERS IN THE CLASSROOM**

Because the released topic for this guide is the Cycling of Matter, teachers can coordinate some of the recommended activities with their cycling of matter instructional units to reinforce regular classroom activities.

**Understanding How the Gateway Assessment is Scored**

- Conduct a practice Gateway Assessment early in the school year to assess instructional needs in the basic skills of scientific writing.

- Explain the purpose of four scoring domains in the Gateway Assessment using the definitions provided in this guide.

- Expose students to the scoring rubrics by using the Gateway domains to give feedback on classroom assignments.

- Give each student a copy of the Gateway Student Friendly Rubric and conduct a class discussion to clarify expectations for the Gateway Assessment.

- Keep a set of Gateway science writing anchor models available in the classroom as a student reference and a teaching tool.

**Share and discuss the annotated Gateway responses and writing topic in this guide.**

- As a whole class activity, orally compare and contrast effective and ineffective Gateway responses in each of the four scoring domains.
  - Practice rewriting each bulleted statement in the rubric into a question. These questions can serve as focus questions for analyzing the student responses released in this guide.
    - For example, change “Your reasoning was explained in all parts of the response” to “Is the reasoning explained in all parts of the response?”

- Discuss both the quality of writing and the quantity of writing in the released responses.
  - Depth of Development is not entirely dependent on the length of a student response; however, very brief responses limit the demonstration of competence in every domain.
• Practice improving parts of the ineffective responses in each scoring domain as an individual, class, or homework activity.
  o For Development of Scientific Processes, individual students or small groups can read responses with limited development and suggest improvements for developing each part of the assigned task.
  o For Expression of Scientific Knowledge, individual students or small groups can read responses which contain limited scientific vocabulary and correct any incorrect use of vocabulary or imprecise terminology.
  o For Organization of Scientific Concepts, students can practice rewriting the introductions and conclusions of the responses released in this guide.
  o For Conventions, students can practice correcting sentence formation, usage, and mechanics errors in the responses released in this guide. ELL students can practice orally to develop an ear for Standard American English.

CONDUCTING A PRACTICE GATEWAY ASSESSMENT

Developing Writing Tasks
• Create a bank of sample biology writing topics to share within the school and with other Gwinnett County high schools.
  o Use the topics in the “Academic Knowledge” section of the high school AKS for Biology and Chemistry as the basis for developing practice test questions.
  o Each Gateway writing topic consists of a Scientific Background statement and a Writing Task.
    ▪ The Writing Task explains the general theme of the assigned task: (“Write an essay that explains the changes involved in the cycling of matter.”).
    ▪ The Writing Task also instructs the writer about specific information which must be included in the response (“Describe a food web in detail, State the Law of Conservation of Matter and Energy and explain how this law applies to photosynthesis and cellular respiration; Describe how carbon is cycled between living organisms and their environment”).
    ▪ Each part of the Writing Task requires the writer to explain and apply facts, concepts and principles from the topic. Make sure that each part of a practice Gateway writing tasks accesses Level Three or Four of the Depth of Knowledge (DOK) classification.
    ▪ Review the parts of a Gateway Task with students and ask them to generate sample Writing Tasks.
Administering a Gateway Practice Assessment

- Practice assessments should follow the procedures outlined in the Gateway Examiner’s Manual.

- Encourage students to use the Gateway writing checklist during the practice assessment.

- Practice assessments may be appropriate for both ninth and tenth grade students; however, the timing of the practice assessment may have an impact on how best to interpret the results. An assessment administered at the beginning of the tenth grade school year may not predict how much content area recall students will demonstrate six months later during the actual administration of the Spring Gateway Assessment. Also, students who take a practice Gateway during the ninth grade may not perform the same way near the end of their tenth grade year. Gateway practice assessments in ninth and early tenth grade may identify at risk students, but may not serve as effective predictors for other student groups.

- The primary value of conducting a practice Gateway may lie in the practice it provides for the actual Gateway assessment. A practice Gateway provides practice writing in a timed context with no outside resources and can help familiarize students with both the format for the assigned task as well as the scoring expectations, because student responses can be scored and returned.

Scoring a Gateway Practice Assessment

There are many options for how to score a practice Gateway Assessment:

- Independent Scoring: The teacher scores only the writing samples produced in his or her own classroom.

- Pair Scoring: Two high school teachers score each writing samples separately then discuss any differences in scores. The two teachers might both be content area teachers or one may be a Language Arts teacher.

- Cooperative Scoring (school level): All high school science teachers discuss and score the writing samples together or trade samples to score. Each sample may be scored by more than one person.

- Cooperative Scoring (system level): Science teachers from different schools work together to score the samples from that system. Two teachers score each writing sample and differences are resolved by another teacher or a panel trained in using the Gateway rubrics.
Writing To Learn

“Writing is thinking made visible.” (Stephen A. Bernhardt)

In the Gateway Assessment for Science, students write to demonstrate what they have learned in biology and chemistry, but writing in the classroom can also be a vehicle for learning throughout the school year. Research indicates that writing gets students actively engaged with subject matter and promotes deeper understanding of scientific processes. Content area teachers can use informal and formal writing assignments in the classroom to teach content and to assess their students’ understanding of course material.

Creating effective writing to learn assignments in science requires planning and structure but does not require extensive training in the language arts. Many writing educators recommend a format called a mini-lesson, based on the work of Lucy Calkins and the Reading and Writing Project. A mini-lesson focuses on one specific aspect of the writing process such as generating ideas, finding a focus, using graphic organizers, or revising to clarify major ideas. These can all be adapted to writing in science.

Most writing mini-lessons have several steps which are common to all good teaching practices: making a connection to the students’ prior knowledge to set the context, introducing a specific teaching point and explaining its purpose, modeling by conducting a think aloud for the entire class, giving students the opportunity to practice the skill or strategy with teacher assistance and individual feedback, and providing an opportunity for independent practice. Although high school students may have many years of writing instruction, they will benefit from multiple opportunities to practice scientific writing in the classroom.

Even shorter writing assignments that require analysis and interpretation of scientific processes will provide valuable practice for the Gateway Assessment and reinforce the concepts being taught throughout the school year. Science teachers can also use these assignments as formative assessments during each unit to check student comprehension of the course material. It is not necessary to score every informal written assignment. Teachers can use whatever criterion is regularly assigned to homework or out of class reading assignments.

Time constraints are an issue for classroom teachers in every content area. Incorporating writing to learn activities into the science curriculum may require significant up front planning time. Teachers can ask their schools and systems for planning time during the year to develop a bank of science writing activities that can be shared within and across schools. This initiative can include science teachers and language arts teachers from both the high schools and middle schools. Effective scientific writing for the Gateway requires cognitive skills that take several years to develop.
The following ideas are suggestions for informal writing assignments. Teachers should model the expectations for these assignments and compose a sample with the whole class.

- At the beginning of the school year, teachers and students compile a list of the themes or big ideas in biology and chemistry using the AKS as a guide. For each textbook reading assignment, students could complete a brief analysis (one paragraph) of one scientific theme covered in the assignment. For example, in a reading assignment covering the Cycling of Matter, students could choose to explain an individual animal or plant’s role in a food chain, the scientific laws that operate in an ecosystem, or the relationships between biotic and abiotic factors. These assignments could be compiled into review guides for classroom assessments and the Gateway Assessment. Teachers who use these assignments for formative assessments will receive feedback on what themes in Biology and Chemistry are most challenging for high school students.

- Write/draw a concept or flow map for one of the scientific processes in the reading assignment or lecture material. (See the example from Cycling of Matter topic on page 141). Diagramming and mapping science content provides a mental schema that aids retention of the major concepts in a content area and breaks the writing process down into smaller steps. A class collection of concept maps would demonstrate that there is more than one correct way to organize information and serve as an effective prewriting strategy for more formal writing assignments in science.

- Review the meanings of arrows in scientific diagrams (page 132) and remind students to precisely label what each arrow in their maps represents.

- Discuss and model what constitutes evidence in scientific writing.
Energy Transfer Concept Map

- **Sun**
  - Energy
- **Producers** (Plants, Algae)
  - Recycle Minerals
  - Waste
  - Food & Oxygen
  - Minerals & CO₂
- **Decomposers** (Bacteria, Fungi, Worms)
- **Consumers** (Animals)
  - Wastes

This diagram illustrates the flow of energy in an ecosystem, starting with the Sun providing energy to Producers, which are then consumed by Consumers and eventually broken down by Decomposers.