**Evidence-Based Writing in Science**

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**Introduction**

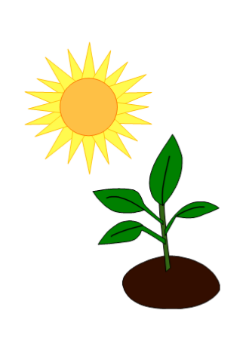
Deep learning in science requires students to gather, reason with, and communicate scientific information.  These skills will also prepare students for college and career success.  Because of the importance of these skills, the new Georgia Milestones Assessment System will require students to demonstrate their ability to comprehend, reason with, and respond to textual and graphical information through a combination of selected-, constructed-, and extended-response items.  At the heart of these skills lies students’ ability to make and evaluate claims based on various types of evidence and on their understanding of key ideas and concepts within various science disciplines.  Teachers in all science classrooms can apply writing tasks designed around the ***Claim-Evidence-Reasoning (CER)*** framework as both learning and assessment tasks for students.

**Q-CER Graphic Organizer**

Use this graphic organizer to support student thinking within the CER framework and as a ***pre-writing*** organizer for extended-response items. After completing the graphic organizer, students should be ready to develop a clear, coherent, and complete written argument that draws on core science concepts and crosscutting ideas.

|  |  |
| --- | --- |
| **Question:** (This is the question provided in the task.) | |
| **Claim:** (Often you can use part of the question to formulate your claim. In an extended response, this will be your topic or thesis sentence.) | **Evidence:** (This is data gathered from text or graphics that help you answer the question provided in the task. Choose a quote or other evidence that directly supports your claim. If you use a quote, then be sure to credit the quote properly.) |
| **Reasoning:** (This is the most important part of your answer. It provides your reader with the explanation for your claim, and it explains how your evidence supports your claim. This is also where you should draw on key ideas and concepts from the discipline to tie your evidence to your claim.)  The evidence shows:  I know (relevant disciplinary ideas – i.e., scientific facts and concepts that help answer the question):  I can apply (relevant crosscutting concepts – i.e., big ideas that connect the concepts and evidence):  Therefore, I can conclude that: | |

**Sample Argument: Light & Plant Growth**

Two biology students, Christina and Andrew, set up an experiment to help them determine how light affects plant growth. The students placed bean seedlings in three locations with their classroom and measured the growth of the bean seedlings over the next five days. Bean seedlings that were placed in a dark closet grew 5 cm in 3 days, but then stopped growing. Bean seedlings that were placed on a countertop away from the window grew 10 cm in 5 days. Bean seedlings that were placed on a windowsill with full sunlight grew 15 cm in 5 days when. Andrew and Christina discussed the results of their experiment.

Christina: “Well, light helps plant grow. The plants on the countertop got some light and were able to grow. The plants in the window got more light, and that’s why those plants grew the most.”

Andrew: “That’s true, but the plants in the closet did grow some. So, plants must not always need light to grow.”

Christina: “Well I remember learning in class that light gives plants energy, and they need the energy to grow. The plants in the closet must have had some energy stored up. But without light, they ran out of energy and stopped growing.”

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| --- | --- |
| **Question:** How does light affect plant growth? | |
| **Claim:**   * Light provides energy that plants need to grow | **Evidence:**   * No light: initial growth, then death   + 5 cm / 3 d, then died * Moderate light: moderate growth   + 10 cm / 5 d * Full light: highest growth   + 15 cm / 5 d |
| **Reasoning:**  *The evidence shows:*   * The evidence shows that increasing amounts of light produced increasing amounts of growth in the seedlings. The evidence also shows that seedlings were able to survive only for a short time without light.   *I know (relevant disciplinary ideas – i.e., scientific facts and concepts that help answer the question):*   * Sunlight is a form of energy * Plants need light to make their own food through to survive (photosynthesis) * Seeds can store energy   *I can apply (relevant crosscutting concepts – i.e., big ideas that connect the concepts and evidence):*   * Energy is required for all processed in living organisms * Energy can be converted from one form to another (light🡪chemical)   *Therefore, I can conclude that:*  From the evidence, we can infer that plants can grow from seeds for a short time without light, but they need light to continue growing. Brighter light causes plants to grow faster than dimmer light. We know that light provides energy to plants. Therefore, seeds must have some way of storing energy for the new plant. Once that energy is used up, the plant can no longer grow unless it has light. Plants must have light because it provides energy for photosynthesis, which allows plants to make food. | |

**Practice**

Select a writing prompt from the OAS sample items that is most relevant to your subject area. Then use the Q-CER graphic organizer to analyze both an extended-response test item.

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| --- | --- |
| **Question:** | |
| **Claim:** | **Evidence:** |
| **Reasoning:**  The evidence shows:  I know (relevant disciplinary ideas – i.e., scientific facts and concepts that help answer the question):  I can apply (relevant crosscutting concepts – i.e., big ideas that connect the concepts and evidence):  Therefore, I can conclude that: | |

**Claim-Evidence-Reasoning Rubric**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **4**  **Advanced** | **3**  **Proficient** | **2**  **Progressing** | **1**  **Beginning** |
| **Claim**  *A statement or conclusion that answers the original question or problem.* | * Makes a claim that is relevant, accurate, and complete. * Contrasts the claim to an alternative claim. | Makes a claim that is…   * Relevant (Directly & clearly responds to question) * Accurate (Consistent with evidence and scientific principles) * Complete (Complete sentence that stands alone) | * Makes a relevant and accurate but incomplete claim. | * Does not make a claim, or makes an inaccurate or irrelevant claim. |
| **Evidence**  *Scientific data that supports the claim. The data need to be appropriate and sufficient to support the claim.* | * Provides appropriate and sufficient evidence to support claim. * Discusses evidence that would support alternative claim. | Provides evidence to support the claim that is…   * Appropriate (Scientific data or information from observations, investigations, data analysis, or valid scientific sources) * Sufficient (Enough evidence to support the claim) | * Provides appropriate, but insufficient evidence to support claim. May include some inappropriate evidence. | * Does not provide evidence, or only provides inappropriate evidence (Evidence that does not support claim). |
| **Reasoning**  *A justification that connects the evidence to the claim. It shows why the data counts as evidence by using appropriate and sufficient scientific principles.* | * Provides reasoning that clearly connects the evidence to the claim. * Includes appropriate and sufficient scientific principles to explain why the evidence supports the claim. * Explains why the alternative claim is inaccurate. | Explanation provides reasoning that is…   * Clear (Clearly communicated and goes beyond repeating claim and evidence) * Connected (Explains why the evidence is important or why it is relevant) * Integrated (Links the evidence to an important disciplinary idea and crosscutting concept) | * Provides reasoning that connects the evidence to the claim. May include some scientific principles or justification for why the evidence supports the claim, but not sufficient. | * Does not provide reasoning, or only provides inappropriate reasoning. |

**Claim-Evidence-Reasoning Student Writing Checklist**

**How to use this checklist:**  A good scientific argument has three main parts (claim, evidence, and reasoning), and an excellent argument also includes a rebuttal of an alternative claim.  Giving a rebuttal means that you explain why the other claim is not correct.  All the criteria listed below will be used to evaluate your written argument.  At a minimum, you need to be sure your argument satisfies the main criteria.  If you want a really outstanding argument, then you also need to address the advanced criteria.

**Claim -** *Your claim should be a statement that answers the original question or problem. It should be…*

**Relevant**: Does my claim directly and clearly respond to question?                    **YES or NO**

How did I do this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Accurate**: Is my claim consistent with both evidence (e.g., data and observations) and scientific concepts I have learned in class?                                            **YES or NO**

How did I do this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Complete**: Is my claim written in complete sentences that someone could understand even if they had not seen the original question?                                            **YES or NO**

How did I do this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Advanced****: Have I contrasted my claim to an alternate or opposing claim?* ***YES or NO***

*How did I do this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

**Evidence –** *Your evidence is the scientific data that supports the claim. Your evidence should be...*

**Appropriate**: Is my evidence based on scientific data or information from observations, investigations, data analysis, or valid scientific sources?                                        **YES or NO**

How did I do this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Sufficient**: Have provided enough evidence to support my claim?                    **YES or NO**

How did I do this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Advanced****: Have I discussed evidence that would support an alternate or opposing claim?* ***YES or NO***

*How did I do this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

**Reasoning –** *Your reasoning should provide a justification that clearly connects the evidence to the claim. It shows why the data counts as evidence by using appropriate and sufficient scientific principles. Your reasoning should be...*

**Clear**: Did I communicate my argument in a way that goes beyond repeating my claim and evidence?  **YES or NO**

How did I do this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Connected**: Did I explain why the evidence is important and why it is relevant to my claim? **YES or NO**

How did I do this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Integrated**: Did I link my evidence to an important scientific concept (e.g., physical/chemical properties) and big idea (e.g., structure & function)?                                        **YES or NO**

How did I do this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Advanced****: Did I explain why the alternate or opposing claim is inaccurate?* ***YES or NO***

*How did I do this? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

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|  |  |  |
| --- | --- | --- |
| **Claim -** *Your claim should be a statement or conclusion that answers the original question or problem. Someone should be able to understand the claim even if they have not seen the original question.* | | |
| **My claim is…** | | |
|  | **Relevant**: It directly & clearly responds to question. |  |
|  | **Accurate**: It is consistent with evidence and scientific principles. |  |
|  | **Complete**: It is written in a complete sentence that stands alone. |  |
|  | ***Advanced****: I have contrasted my claim to an alternative claim.* |  |
| **Evidence –** *Your evidence is the scientific data that supports the claim. The data need to be appropriate and sufficient to support the claim.* | | |
| **My evidence is…** | | |
|  | **Appropriate**: It is scientific data or information from observations, investigations, data analysis, or valid scientific sources. |  |
|  | **Sufficient**: I have provided enough evidence to support the claim. |  |
|  | ***Advanced****:* *Discusses evidence that would support alternative claim.* |  |
| **Reasoning –** *Your reasoning should provide a justification that clearly connects the evidence to the claim. It shows why the data counts as evidence by using appropriate and sufficient scientific principles.* | | |
| **My reasoning is…** | | |
|  | **Clear**: It clearly communicates my argument and goes beyond repeating claim and evidence. |  |
|  | **Connected**: It explains why the evidence is important and why it is relevant. |  |
|  | **Integrated**: It links the evidence to an important disciplinary idea and crosscutting concept. |  |
|  | ***Advanced****:* *Explains why the alternative claim is inaccurate.* |  |

**References:**

***Graphic Organizer & Supporting Information***

Claim-Evidence-Reasoning Mini-tasks in the LDC Curriculum Library

CSQT Framework, Downloaded from: <http://www.teacherweb.com/de/christianahighschool/corsello/csqt_dstp_prep.ppt>

Llewelyn, D., & Rajesh, H. (2011). Fostering argumentation skills: Doing what real scientists really do. *Science Scope, 35* (1), 22-28.

Sampson, V., and Schleigh, S. (2012). Scientific Argumentation in Biology, 30 Classroom Activities. Arlington, VA: NSTA Press

***Rubric Adapted from***

McNeill, K.L., and Krajcik, J. (2012). *Supporting grade 5-8 students in constructing explanations in science: The claim, evidence, and reasoning framework for talk and writing.* Boston: Pearson.

Rewitz, W. (2011). *Make Your Probe Explanation Cl-Ev-R.* Downloaded from <http://www.uncoveringstudentideas.org/resources/tips-and-strategies>.

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