Supporting All Students in Writing Scientific Arguments

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Agenda
- Presentation: Introduction to Argument
- Activity 1: Write an argument
- Discussion of writing
- Activity 2: Analyze student writing
- Discussion of student writing
- Presentation: Common student challenges and a learning progression

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Common Core ELA Standards (6-8)

1. Write arguments focused on discipline-specific content.
   a. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
   b. Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.
   c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons and evidence.
   d. Establish and maintain a formal style.
   e. Provide a concluding statement or section that follows from and supports the argument presented.
Next Generation Science Standards (NGSS)

- Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

  (6-8)
  - Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.
  - Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts.

Writing Scientific Arguments using the CER framework

Adapted from Toulmin (1958)

- **Claim**
  - a conclusion about a problem or answer to a question

- **Evidence**
  - scientific data (observations, measurements) that support the claim

- **Reasoning**
  - Uses science concepts to show why the evidence supports the claim

- **Rebuttal**
  - describes alternative explanations and provides counter evidence and reasoning for why the alternative is not appropriate.
Physical science example

What type of pulley system requires the least force to move the block?

A pulley system with two moveable pulleys and one fixed pulley required the least amount of force to move the block. (Claim) This system took an average of 0.82 Newtons to move the block. We tried three other systems, but the closest one was still 0.23 Newtons more, because it required 1.05 Newtons. (Evidence) The fixed pulleys just change the direction of the force, while moveable pulleys reduce the amount of force. Using one fixed, let us have two moveable pulleys, which decreased the force more than just having one moveable pulley. (Reasoning)

Earth science example

How can sun shadows be used to tell time?

The length of the sun shadow can be used to tell time. (Claim) At 10:45am, the shadow was 20 cm and the sun was low. At 12:25pm, the shadow was 17 cm and the sun was high. Finally, at 2:15pm the shadow was 21 cm and the sun was low. Shadows are longer in the morning and afternoon while they are shorter at noon. (Evidence) The length of the shadow is determined by how high the sun is in the sky. The sun changes position in the sky, because the earth rotates once each day. When the sun is higher in the sky, the shadows are shorter, which is why they can be used to tell time. (Reasoning)

Life science example

What will happen to the shark population if the phytoplankton populations die out?

The shark population will die out. (Claim) The shark eats other fish such as the ocean fish and the lantern fish. The ocean fish and the lantern fish eat other organisms such as shrimp and copepods. The shrimp and copepods eat the phytoplankton. (Evidence) Phytoplankton are producers and they make their own food from the sun. All of the other organisms in the food web depend on the phytoplankton, even if they do not directly eat them. If the phytoplankton die, primary consumers (shrimp and copepods) will die because they will have no food which will cause the secondary consumers (ocean fish and lantern fish) to die, which will cause the shark to die. (Reasoning)

Life science example

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CER variations

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<th>Framework Sequence</th>
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Density Investigation: Write a scientific argument

- Examine the data from the density investigation.
- Write an ideal 7th grade student response to the question – Which ball(s) will sink? Remember to support your claim with appropriate evidence and reasoning.

Discussion

- Would somebody like to share the argument they wrote about which ball(s) will sink?
- Did anybody write a different argument?
- Why did you use certain pieces of data as evidence over others?
- What are some of the challenges you think your students might have with this writing task?

General Rubric for Assessing Written Arguments
LEVER EXPERIMENT

• Students use a lever and a spring scale to measure the effort needed to lift a load when:
  1. The position of the load remains constant and the position of the effort changes
  2. The position of the effort remains constant and the position of the load changes

• Students can use their data to support the claim – A lever sometimes makes work easier.

Specific Rubric for Lever Data

Activity 4: Analyzing Student Writing - Rubrics

• With a partner(s), score the 3 student responses using the specific rubric. For each student give them a separate score for:
  - Claim - 0, 1 or 2
  - Evidence - 0, 1, 2, or 3
  - Reasoning - 0, 1, or 2

• If you have time, think about what feedback you might provide these students.

Discussion of Student Writing

• What were the strengths of each piece of writing?
• Where do these students need additional support?
• What are some of the difficulties you think your students would have with this type of task?
• How would you support your students in improving their CER writing over a school year?
Common Student Challenges: Using evidence

Students can:
• Just repeat that the experiment or the data table is their evidence
• Rely on their own opinions or personal experiences instead of appropriate data
• Have difficulty using enough or sufficient data
  • May focus on one piece of data
• Struggle with using different types of data
  • May focus on quantitative and not consider qualitative data

Common Student Challenges: Providing reasoning

Students can:
• Omit describing why they chose or did not use certain data
• Have difficulty describing the link between the claim and evidence
• Struggle with including a general scientific principle

Instructional Moves

1. Critique examples of written arguments
2. Ask students to highlight in different colors or in different ways (i.e. circle, #, underline) the CER in writing.
3. Provide graphic organizers and other scaffolds (i.e., sentence starters) for writing
4. Create a multiple-choice format where students have to select the strongest reasoning
5. Use a card sort activity where students have to arrange evidence cards for a claim.
Critique examples

Argument #1
Polar bears can live in the Arctic, because they have adaptations for the environment. Their webbed paws allow them to swim through the water to catch seals. Their claws also allow them to catch seals. Their fur keeps them warm in the cold environment. Adaptations are characteristics that allow an animal to survive in its environment. Getting food and staying warm are both necessary for an animal to live.

Argument #2
Polar bears are able to survive in their natural environment, because they like to live where it is cold. They always live somewhere that has lots of snow and ice and water. The Arctic has lots of snow and ice and water, which is why they are able to live there. They would not be able to live some place that was warm and did not have any snow. For example, they could not live in Hawaii because it is too warm there.

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Label CER

Write a scientific explanation stating whether fat and soap are the same substance or different substances.

Fat and soap are different substances, because they have completely different results based on their properties.

You need specific evidence.

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Use scaffolds, discussion prompts and graphic organizers

Evidence

[Describe data that supports the claim]

Reasoning

[Explain how the evidence supports the claim]

Claim

[State your position on the issue]

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Multiple-Choice Format

How sure are you that it is true? Write the number below that you feel represents the strength of your argument.

SURE

Not at all

A. No evidence that atrazine decreases biodiversity in lakes
B. No evidence that atrazine decreases biodiversity in streams
C. No evidence that atrazine decreases biodiversity in rivers
D. No evidence that atrazine decreases biodiversity in lakes, streams, and rivers

Reasoning

[Describe the data and its implications]

[Explain how the evidence supports the claim]

[State your position on the issue]

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Card Sort Activity

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Conclusions

- Argumentation is an important goal in current ELA and science standards documents
- The CER framework can help support students in writing arguments
- Developing expertise in argumentation takes time – students can have many challenges
- A variety of instructional supports can be used to support students in writing arguments.

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