



## Supporting All Students in Writing Scientific Arguments

Rebecca Katsh-Singer, Daniel Pimentel,  
Maria Gonzalez-Howard & Katherine L. McNeill

Boston College



## 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

<http://www.katherinelmcneill.com>



## 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.



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## 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.

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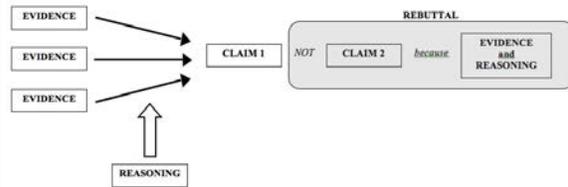
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## Writing Scientific Arguments using the CER framework

*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.

## CER Framework *Adapted from Toulmin (1958)*



## 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 17cm 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)**

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## CER variations

Level of Complexity	Framework Sequence
Simple ↓ Complex	Variation #1 1. Claim 2. Evidence
	Variation #2 1. Claim 2. Evidence • Multiple pieces
	Variation #3 1. Claim 2. Evidence • Multiple pieces 3. Reasoning
	Variation #4 1. Claim 2. Evidence • Multiple pieces 3. Reasoning 4. Rebuttal

## Density Investigation: Write a scientific argument

- Examine the data from the density investigation.
- Write an ideal 7<sup>th</sup> 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

Base or Generic CER Rubric

	Claim	Evidence	Reasoning
	<i>A statement or conclusion that answers the original question/problem.</i>	<i>Scientific data that supports the claim. The data needs to be appropriate and sufficient to support the claim.</i>	<i>A justification that connects the evidence to the claim. It shows why the data counts as evidence by using appropriate and sufficient scientific principles.</i>
0	Does not make a claim, or makes an inaccurate claim.	Does not provide evidence, or only provides inappropriate evidence (evidence that does not support claim).	Does not provide reasoning, or only provides inappropriate reasoning.
1	Makes an accurate but incomplete claim.	Provides appropriate, but insufficient evidence to support claim. May include some inappropriate evidence.	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.
2	Makes an accurate and complete claim.	Provides appropriate and sufficient evidence to support claim.	Provides reasoning that connects the evidence to the claim. Includes appropriate and sufficient scientific principles to explain why the evidence supports the claim.



### **LEVER EXPERIMENT**

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

This investigation is part of the FOSS Levers and Pulleys Module © The Regents of the University of California. Can be duplicated for classroom or workshop use. Investigation 1: Levers

### **Specific Rubric for Lever Data**

	<b>Claim</b> <i>A statement or conclusion that answers the original question/problem.</i>	<b>Evidence</b> <i>Scientific data that supports the claim. The data needs to be appropriate and sufficient to support the claim.</i>	<b>Reasoning</b> <i>A justification that connects the evidence to the claim. It shows why the data counts as evidence by using appropriate and sufficient scientific principles.</i>
0	Does not make a claim, or makes an inaccurate claim like - "Levers do not effect work."	Does not provide evidence, or only provides inappropriate evidence or vague evidence, like "the data shows me it is true" or "it would be a lot harder to move a plane without a lever"	Does not provide reasoning, or only provides inappropriate reasoning like "levers are used in lots of ways in our lives"
1	Makes an accurate but vague or incomplete claim like - "Levers make work easier." Or "Levers do not make work easier." (It can actually depend).	Makes a general statement about how in the investigation levers sometimes made the work easier and sometimes did not make the work easier. Does not include specific data.	Provides 1 of the following 2 reasoning components: <ul style="list-style-type: none"> <li>A lever can make work easier depending on the position of the fulcrum, effort and load.</li> <li>Doing work is the ability to move an object. If it takes less force, the work is easier.</li> </ul>
2	Makes an accurate and complete claim like - "Levers sometimes make work easier."	Provides 1 of the following 2 pieces of evidence: <ul style="list-style-type: none"> <li>Specific data (e.g. numbers) from the investigation when the lever made the work easier.</li> <li>Specific data (e.g. numbers) from the investigation when the lever made the work harder.</li> </ul>	Provides all 2 reasoning components: <ul style="list-style-type: none"> <li>A lever can make work easier depending on the position of the fulcrum, effort and load.</li> <li>Doing work is the ability to move an object. If it takes less force, the work is easier.</li> </ul>
3		Provides 2 of the following 2 pieces of evidence: <ul style="list-style-type: none"> <li>Specific data (e.g. numbers) from the investigation when the lever made the work easier.</li> <li>Specific data (e.g. numbers) from the investigation when the lever made the work harder.</li> </ul>	

### **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.

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## 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 & soap are different substances  
because they have completely different  
results based on their properties.

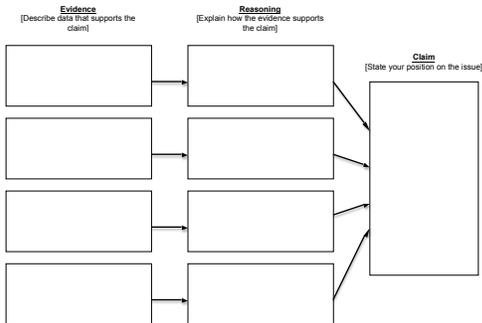
NO evidence

you need pieces of evidence

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## Use scaffolds, discussion prompts and graphic organizers



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## Multiple-Choice Format

How can you design a car to go the fastest? Circle the choices below that you think would create the strongest argument.

### CLAIM

Circle ONE of the following.

- A. My car will go the fastest, because I will make it really strong.
- B. The car with the lightest load being pulled by the largest force will go the fastest.
- C. How fast a car goes is determined by how far it travels in a certain time.

### EVIDENCE

Circle TWO of the following.

- A. The car with only one block on the car took 1 second to travel across the table while the car with three blocks took 3 seconds.
- B. We always built our cars carefully and they traveled really fast.
- C. Car companies, like Ford, try to build light cars because they will travel faster.
- D. The car that was pulled by 8 washers took 2 seconds to travel across the table while the car with 1 washer took 7 seconds.
- E. Our group had a lot of fun building and testing our cars, except for the one day that our car kept breaking.
- F. Our experiments showed that light cars travel faster.

### REASONING

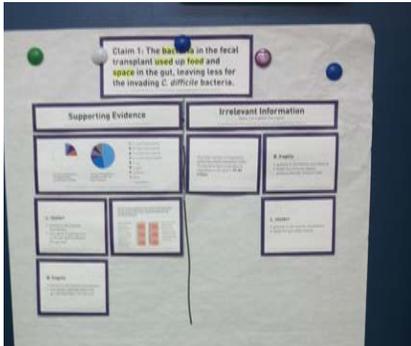
Circle ONE of the following.

- A. The data from our experiments shows us how to build our car. Since the data shows that fast cars have a light load and fast cars are pulled by a large force then this is how we should build our car.
- B. Since car companies and race cars have cars that are really light and have large engines this means we should design our car in the same way. It should have a light load and be pulled by a large force.
- C. The speed was determined by how many seconds it took for the car to travel across the table. The car with less blocks had a lighter load and it traveled faster. The car that was pulled by more washers was pulled by a greater force and it traveled faster.

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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.

## Contact information

- Rebecca Katsh-Singer: [katsh@bc.edu](mailto:katsh@bc.edu)
- Daniel Pimentel: [dannymentel@gmail.com](mailto:dannymentel@gmail.com)
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