I introduced the Claim-Evidence-Reasoning framework….now what?

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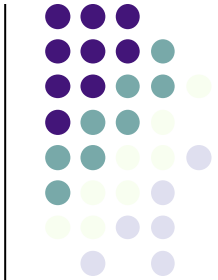
Boston College

Agenda



- Overview of workshop
  - Two challenging areas being targeted in today's workshop:
    - 1. Teaching and supporting scientific reasoning
    - 2. Creating opportunities for students to debate multiple claims
- Presentation: Scientific argumentation and the CER Framework
- Activity #1: Examine student writing
- Activity #2: Video analysis
- Presentation: Strategies to design lessons

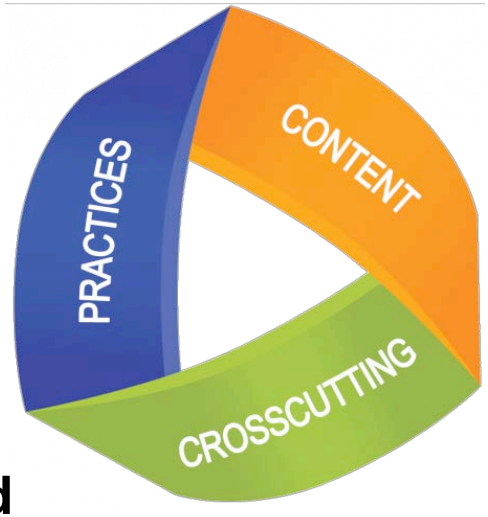
PowerPoint and handouts can be found at:

http://www.katherinelmcneill.com

Link to the Next Generation Science Standards

"Student engagement in scientific argumentation is critical if students are to understand the culture in which scientists live, and how to apply science and engineering for the benefit of society. As such, **argument is a process based on evidence and reasoning that leads to explanations acceptable by the scientific community** and design solutions acceptable by the engineering community… arguments in science goes beyond reaching agreements in explanations…**students are expected to use argumentation to listen to, compare, and evaluate competing ideas and methods based on their merits**. "

– NGSS Release 2013, Appendix F



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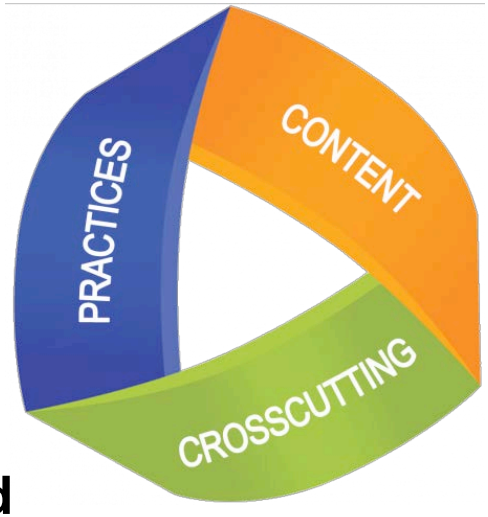
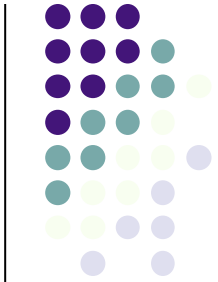


C-E-R Framework

McNeill & Krajcik (2012)



- **Claim**
  - a conclusion about a problem
- **Evidence**
  - scientific data that is *appropriate* and *sufficient* to support the claim
- **Reasoning**
  - a justification that shows why the data counts as evidence to support the claim and includes appropriate scientific principles

C-E-R Framework

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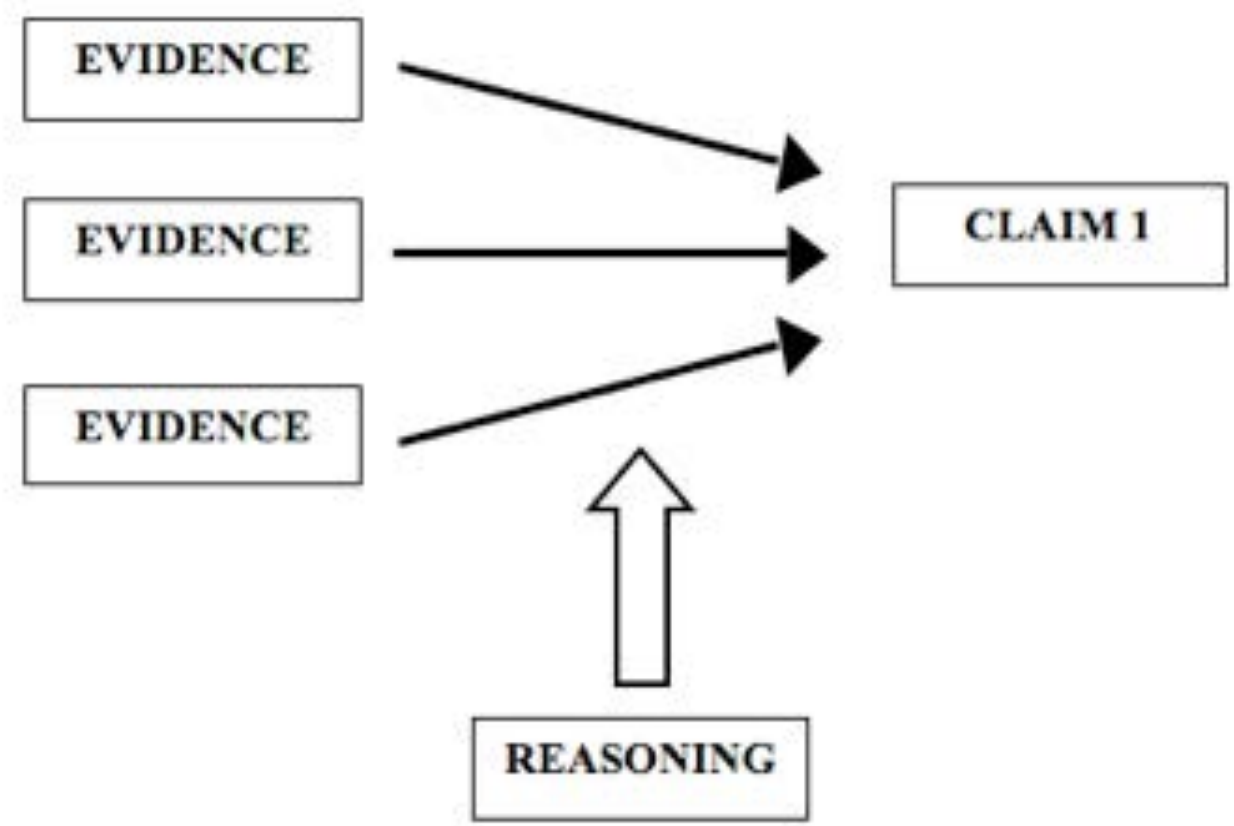

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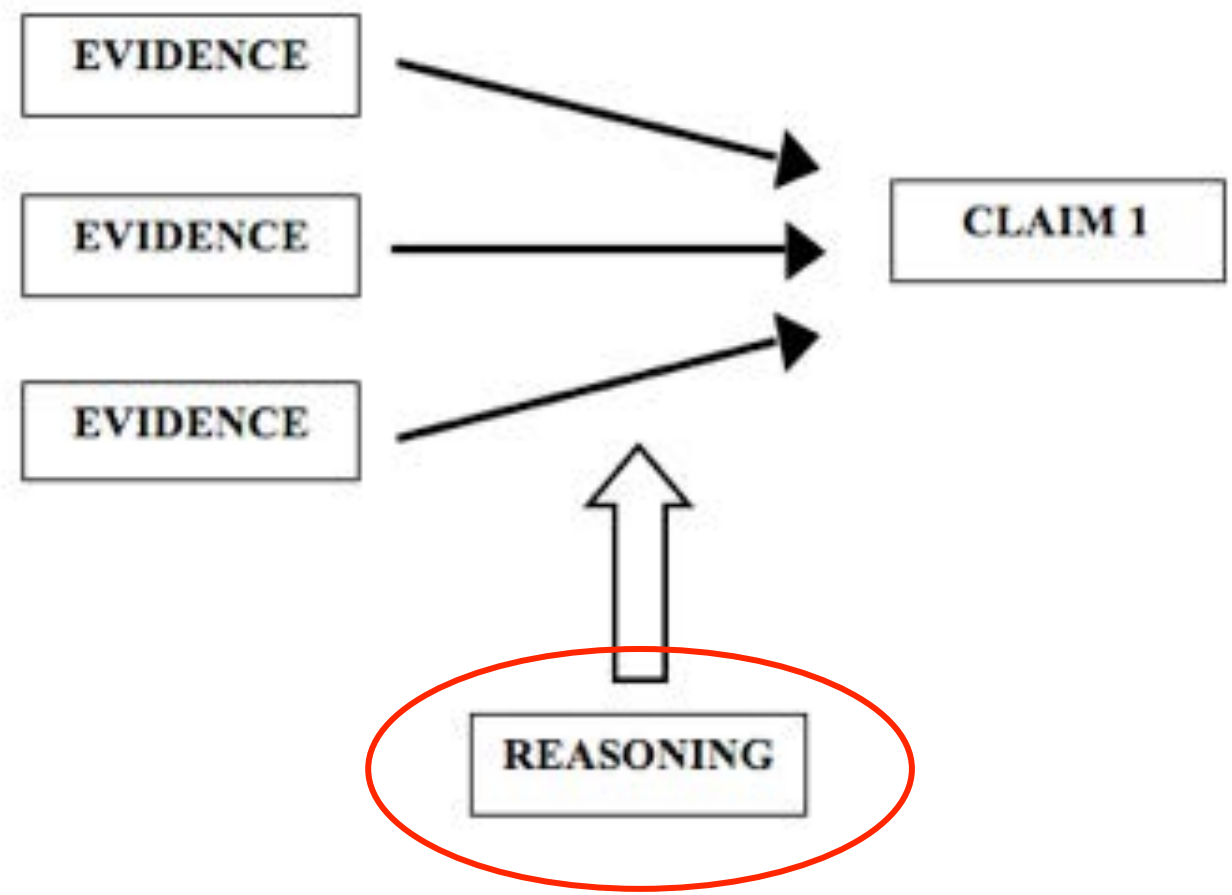


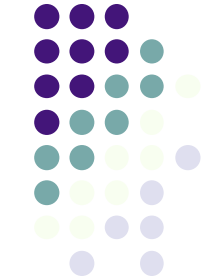
What is reasoning?

- **Reasoning** – uses appropriate and sufficient disciplinary core ideas (concepts, theories, laws) to describe how or why each piece of evidence supports the claim.

- High quality reasoning provides both:
  - A link (why the evidence supports the claim)
  - Science idea (disciplinary core ideas)

- These logical connections make an argument stronger and clearer to understand

Physical Science Example: 4th grade



Question – Does an object's mass affect how quickly it falls?

No, mass does not affect how quickly an object falls. (Claim) In our experiment, the blocks had different masses, 20 g., 30 g., 44 g., 123 g and 142 g but the time for all five blocks to fall was about the same. It took between 1.5 and 1.8 seconds for them to fall. (Evidence) Since the blocks had different masses but took about the same time, I know that mass does not affect how quickly something falls. (Reasoning)

Biology Example: 6th grade

Question – 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)

Physical Science Example: 7th grade

Question – What is air?

Air is matter.(Claim) I think air has mass because in the balloon experiment when we were comparing or weighting the deflated balloon to the balloon filled with air, the balloon filled with air weighted more (Evidence) This is because of mass. Mass means the amount of matter in something. The balloon which had air in it has more mass. (Reasoning) Another reason why I think air has mass is because in the syringe experiment, it was difficult to push the top of the syringe because the air was blocking it from going down (Evidence). The tiny little molecules were trapped in a small space and created more pressure. Air pressure made it difficult to push down because the air takes up space. It is made of matter and has mass. It is true that air is made of matter and has mass (Reasoning).

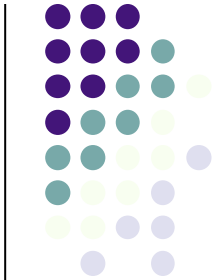
Question -- What causes some earthquakes to have more destructive power than others? How do you know?

- Data:

Location of Earthquake	Destructive Power at the Epicenter (center of the earthquake) (Scale: 0 to 12)	Average Yearly Crust Temperature 1 mile Below Surface (^{0}F)	Hardness of Ground Material
Earthquake A	8	77	Soft
Earthquake B	8	65	Soft
Earthquake C	7	59	Hard
Earthquake D	6	53	Hard
Earthquake E	5	51	Very Hard

- Main Science Ideas:
  - Earthquakes travel through the Earth in waves. The waves begin at the focus, which is where the earthquake starts underground.
  - The epicenter is directly above the focus on the Earth's surface.
  - More powerful earthquakes happen when the focus of the earthquake occurs in soft ground material, because the earthquake waves can travel more easily through soft ground.

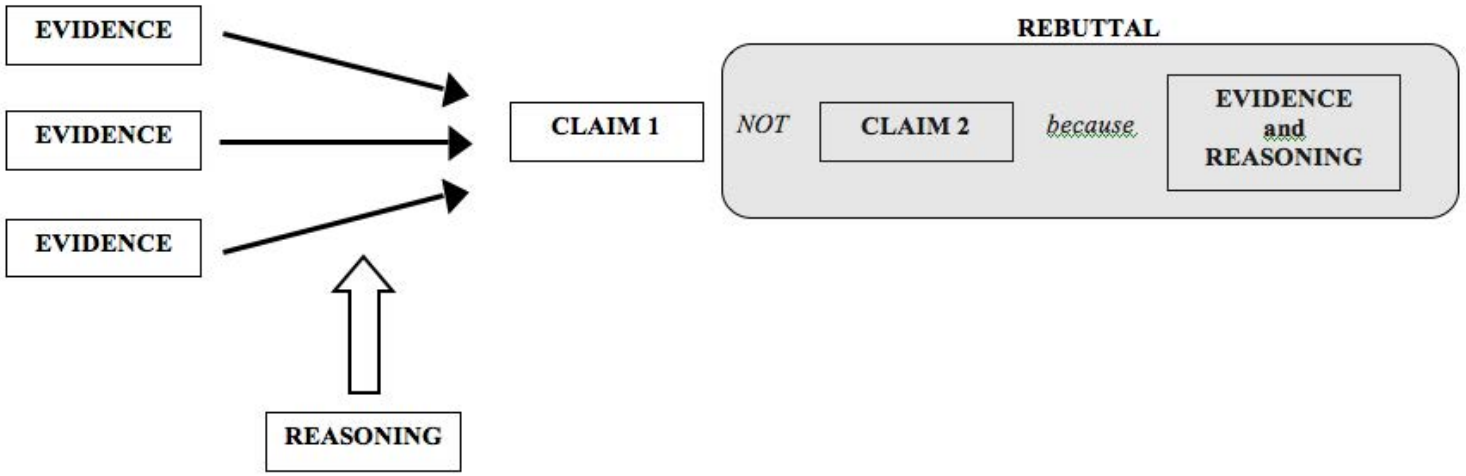
Activity #1: Examine Student Writing



- Working with someone at your table:

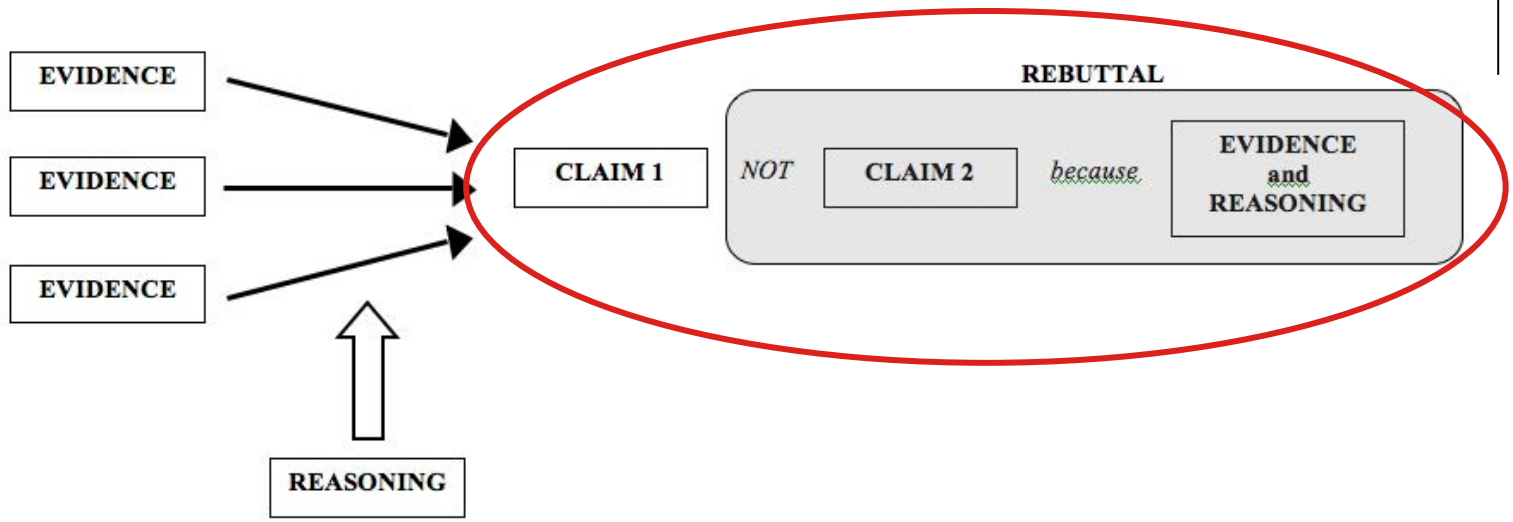
1. For each of the 4 examples:
    1. Circle the claim
    2. Number the pieces of evidence
    3. Underline the reasoning
2. Rank the four samples of student work from strongest (1) to weakest (4) considering the quality of the C-E-R components.
3. Describe the criteria you used to rank the student writing.

Argument as a *structure* and a *process*



- **This science practice involves students engaging in the *process* of argumentation as they construct and refine the *structure* of an argument**
  - The *structure* includes the C-E-R framework of a claim, evidence and reasoning
  - The *process* involves the ways that students collaborate with peers as they question, critique and build off of one another's ideas

Argument as a *structure* and a *process*



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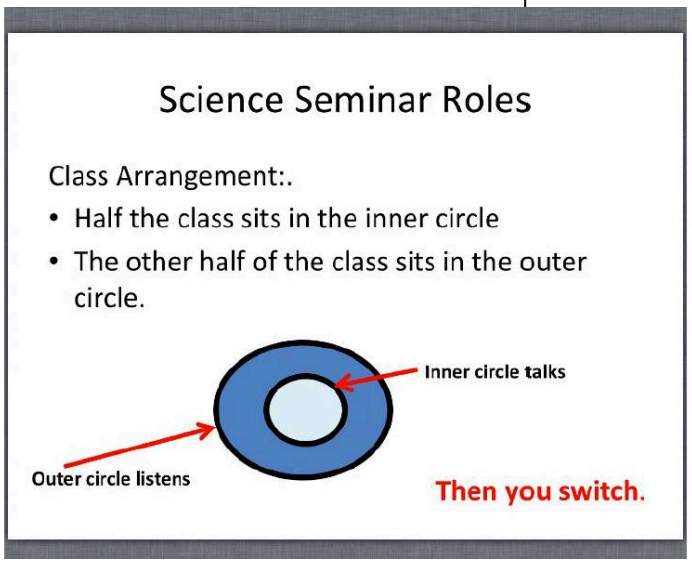
Activity #2: Video analysis

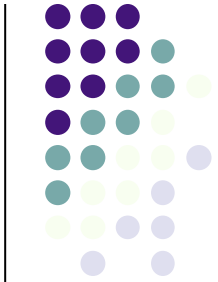
7th Grade Lesson Focus:

- Context: Heredity Unit (Lawrence Hall of Science, 2014)
- Question: What kind of allele causes the glowing trait?
- 3 Possible Claims:
  - The allele for fluorescence is dominant.
  - The allele for fluorescence is non-dominant.
  - The allele for fluorescence is incompletely dominant.
- Evidence: Punnet squares of different crosses of the cats. Data about crosses from jelly fish.
- Activity: Science Seminar



The Argumentation Continuum

sciencepracticesleadership.com (2015)



	The instruction of the 8 science practices reflects strong understanding of the practices and how these practices relate to one another. The teacher engages students in these practices as appropriate to the content under study and the developmental abilities of the students.			
	Level 1	**Level 2**	**Level 3**	**Level 4**
7. Engaging in argument from evidence	Teacher does not provide opportunities for students to engage in argumentation.	Teacher provides opportunities for students to engage in argumentation, but the discourse is primarily teacher-driven. Students rarely provide evidence or reasoning that links their evidence to their claim, nor do they engage in critique of competing arguments.	Teacher provides opportunities for students to engage in student-driven argumentation. The student discourse includes evidence, reasoning that links the evidence to their claim and consideration of competing arguments in which students build on and question each other's ideas. However, students rarely engage in critique.	Teacher provides frequent opportunities for students to engage in student-driven argumentation. The student discourse includes evidence, reasoning that links the evidence to their claim and *critique* of competing arguments during which students build on and question each other's ideas.
Classroom Culture Prioritizing Scientific Practices Less ----------More Student-directed Language-rich Focused on scientific evidence Collaborative				

Watch video: Where would you place it on the continuum?

Take into account the following questions:

- Who is driving the argumentation?
- In terms of argument structure, are students justifying their claims with evidence and reasoning?
- In terms of the argument process, are students:
  - -Questioning one another?
  - -Building off of one another's ideas?
  - -Critiquing multiple competing claims?

7th Grade Example

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Strategies to Design Lessons

- Developing a “good” question
  - Consider whether the CER structural and process elements
  - Consider the clarity of the question
- Choosing the activity structure
  - Examples – Written conclusion for a lab, Card sort activity, Reading & critiquing arguments, Group work with different claims, and Science Seminar
- Designing scaffolds
  - Examples – Writing scaffolds, Discussion prompts, Agree upon criteria, and Graphic organizers

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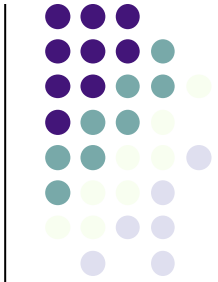
Writing a “good” question



- Consider the structure
  - Includes data the students can use as evidence
  - Potentially provides opportunities to apply disciplinary core ideas
- Consider the process
  - Includes multiple potential claims
  - Provides an opportunity for students to build off of and critique each others’ ideas
- Consider the clarity of the question
  - Is it clear what claim the student should respond with?

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Conclusion for Lab

Write an argument that answers the question: Is my ecocolumn a stable ecosystem?

Claim
(Write a sentence stating whether your ecocolumn is or is not stable.)

I think that is not stable.

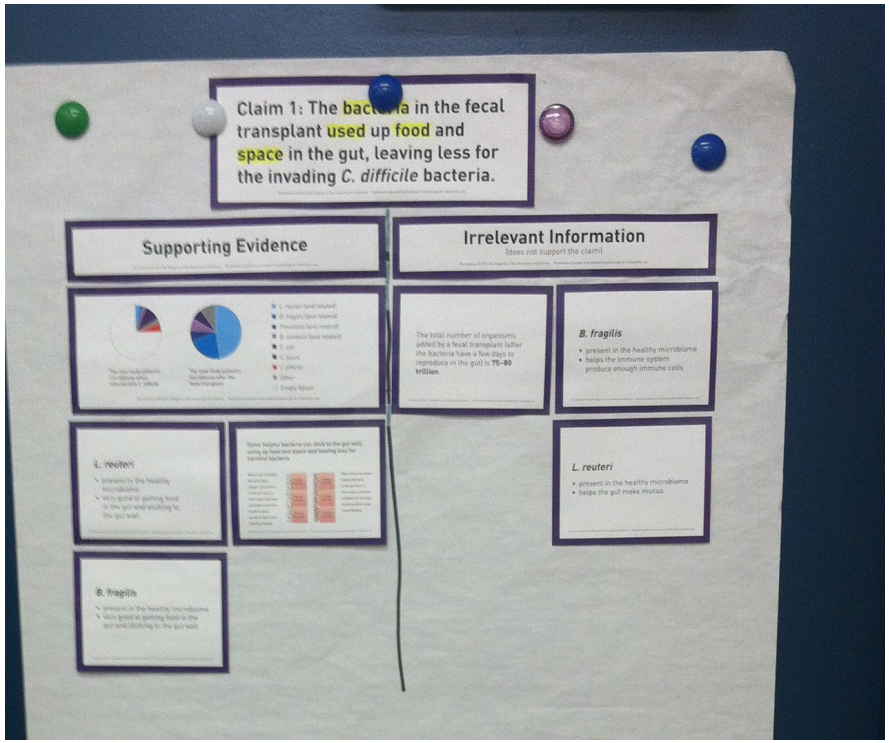
Evidence
(Provide scientific data to support your claim. Use evidence from your table above about the health and changes for the different characteristics of your ecocolumn.)

because they don't more and because the wrate is not clenn. and because the plet are not grewing.

Reasoning
(Explain why your evidence supports your claim. Describe what it means for an ecosystem to be stable and why your evidence allowed you to determine if your ecocolumn was stable.)

~~the~~ I know that astable eco-colamn has living plants and animls. my evidence show that there are no living pants or animals. that is why eco column is unstable.

Card Sort Activity



Reading & Critiquing Arguments

Dinosaur Extinction: Was an Asteroid the Cause?

The Claim:

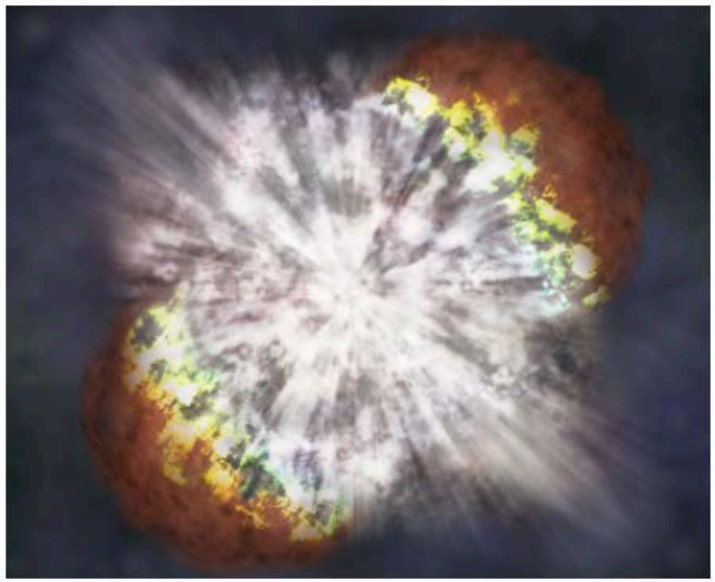
Asteroids are rocks that fly through space. About 65 million years ago, Earth was hit by a huge asteroid about 10 kilometers across—bigger than Mount Everest. When the asteroid crashed, it broke into millions of tiny pieces, sending bits of rock and dust high into the atmosphere. A wide area of Earth's crust melted in the spot where the asteroid hit. The crash caused huge waves that swept across the land around, tearing up trees after the asteroid hit Earth, the dust raised by the crash stayed in the and cooling temperatures. Many species of plants and animals, includi not survive these sudden changes to their environment. This asteroid to go extinct.

An artist created this image of what it might

Dinosaur Extinction: Was a Supernova the Cause?

The Claim:

When very large stars reach the end of their lives, they may explode in an enormous burst called a supernova. Supernovas only last for a few months, but they are millions of times brighter than our Sun. When they explode, supernovas send radiation, gas, and dust out in all directions. About 65 million years ago, a star close to Earth exploded in a supernova. The supernova damaged Earth's atmosphere, which protects Earth from harmful radiation. After the supernova, harmful radiation and dust streamed down on Earth's surface. The radiation killed off many of Earth's species, including the dinosaurs. This supernova caused the dinosaurs to go extinct 65 million years ago.



An artist created this image of what a supernova might look like close up.

image: NASA

Dinosaur Extinction:

Were Volcanic Eruptions the Cause?

The Claim:

About 65 million years ago, volcanic eruptions began happening much more often than usual. Huge amounts of lava erupted each year: about 30 times more lava than now erupts aii. All these volcanic eruptions sent dust and ash and cooling temperatures. Many species of plants uld not survive the cooler temperatures. Because of gradually went extinct.

uptions

image: USGS

Group Work With Different Claims

- Goal is to create a situation where students in a group have different claims, which encourages them to question and critique each other's claims

Example Approach:

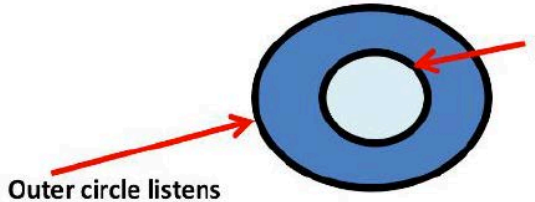
- **Argument Jigsaw:** 2 pairs of students converge to agree on a single explanation or model

Science Seminar

Science Seminar Roles

Class Arrangement:.

- Half the class sits in the inner circle
- The other half of the class sits in the outer circle.



Then you switch.

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Writing Scaffolds

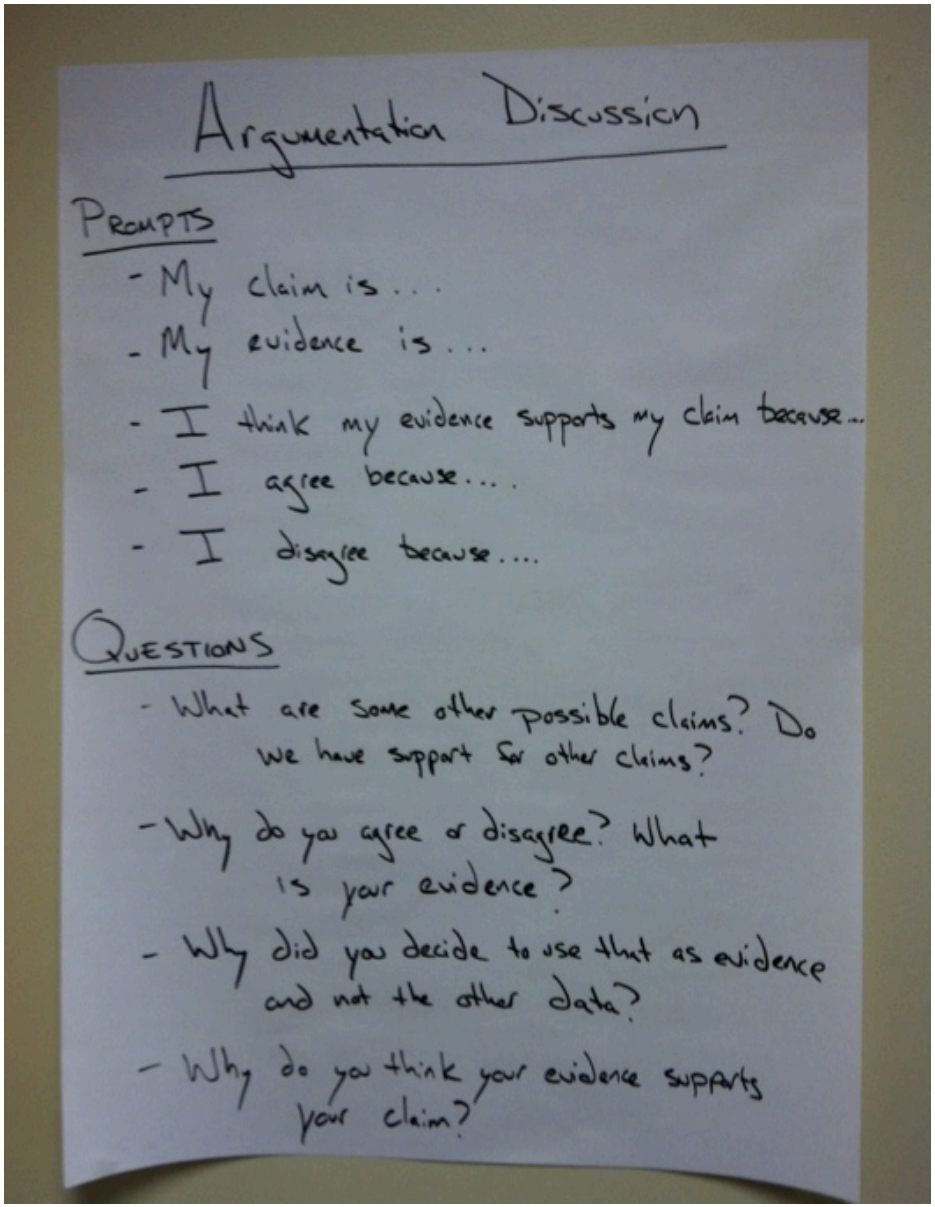
Conclusion:
Write an argument that answers the question: Which bird beak is the best adaptation for this environment?

Claim
[Write a sentence stating which beak is the best adaptation for this environment.]

Evidence
[Provide scientific data to support your claim. The evidence should include the amount of food (marbles, pennies, popsicle sticks & red water) that the beaks ate.]

Reasoning
[Explain why your evidence supports your claim. Describe what an adaptation is and why your evidence allowed you to determine the beak was the best adaptation.]

Discussion Prompts

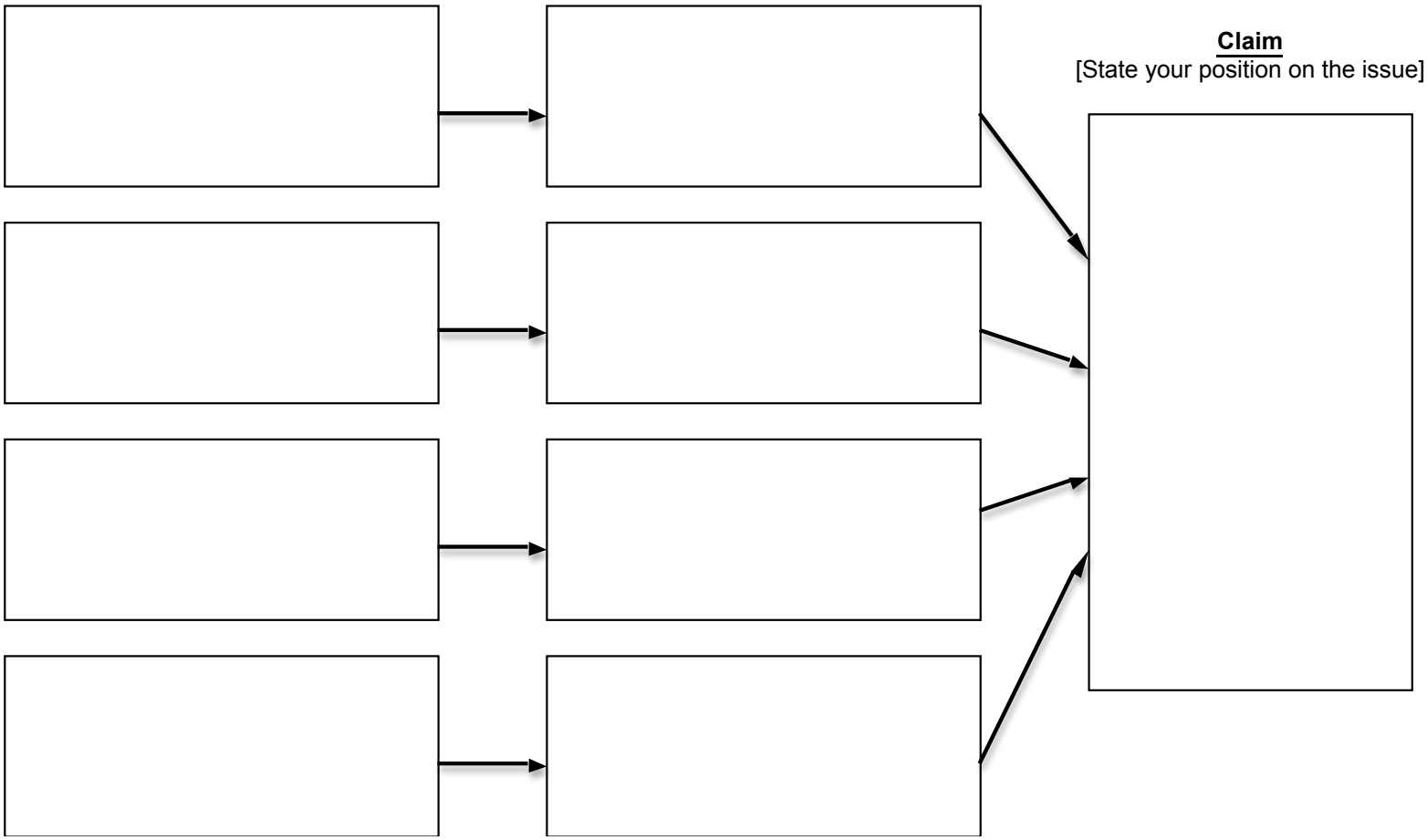


Graphic organizer

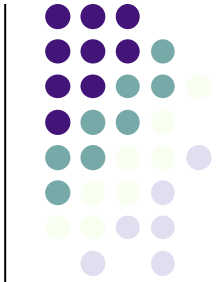
Evidence
[Describe data that supports the claim]

Reasoning
[Explain how the evidence supports the claim]

Claim
[State your position on the issue]



Contact Information



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- Thanks to:
  - National Science Foundation – *Constructing and Critiquing Arguments in Middle School Science Classrooms,* DRL-1119584.
  - National Science Foundation – *Instructional Leadership for Scientific Practices*, DRL-1415541.
  - Colleagues at the Lawrence Hall of Science, University of California Berkeley – Suzy Loper, Phaela Peck, and Traci Wierman