Intra: Evidence and Reasoning Lessons

Is Gravity a Strong or Weak Force?

Goal: In this series of lessons, students choose a claim and support their argument with evidence and reasoning.

Teaching strategy: Evidence sort, Discourse Circle

Works best with: Partnerships, small groups

Preparation:

- Cut out claim strips and evidence cards. Place in plastic baggies (each partnership gets one baggie).
- Write the definition of claim, evidence and reasoning on chart paper and display. Leave space under each definition for an example.
- Write discourse circle routine on chart paper.

Teaching:

Preparing for the activity: What is gravity? (about 30 minutes)

- Start by asking students what they know or have heard about gravity.
- Share some basic information about gravity: Gravity is an invisible pulling force. Earth's gravity pulls things toward the center of the earth. The further apart objects are from each other, the weaker the pull. So, as objects move further away from the earth, the pull of the earth is weaker. All objects (including other planets) have gravity that pull on all other objects. The pull of earth's gravity makes leaving earth difficult. Two things affect the strength of gravity: the mass of the objects involved, and how far apart they are from each other. Because the earth has great mass and is very close to us, its pull is powerful.
- Ask students about the idea of "beating gravity":
    - Pose the following question: Is there a way to break the gravitational pull between you and the earth? How? Encourage your students to show you/ demonstrate. They might jump up/ throw a pencil up in the air, etc. After they share, tell them that although they sort of beat gravity, they always returned back to earth.
    - Now ask, can you jump off the planet? Has anyone ever jumped off the planet? How? (They might bring up space ships/ airplanes)
    - Share with students that in order to beat or escape the pull of gravity, they would have to jumping 25,000 mph (4.3 km per second). That's impossible for a person to do. It takes very powerful rockets to go 25,000 mph, get off the planet, and not fall back.

* These initial preparations require the teacher to share a lot of information orally. Some students learn better with the aid of visuals or when taking notes. This information could easily be shared in a PowerPoint and accompanied by guided notes.

Examining the evidence (about 25 minutes)

- **Introduce the question:** Is gravity a strong or weak force?
- **Prepare for the discourse circle.** Before the discourse circle, students must do some prep work. In total, this work should take about 12 minutes.
- Explain the objective for this series of lessons: Over the course of the next couple lessons, you will collect evidence, choose a claim to support, and explain how your evidence supports your claim through reasoning. These are skills you will do again and again both in the science classroom and beyond.
- Tell students that they will receive some facts about gravity. Some will support the claim that gravity is a strong force, and some will support the claim that gravity is a weak force.
- Explain to students that good scientists gather information before they choose to support a particular claim, and this is exactly what they are about to do. This information will later serve as evidence to support the claim they decide to make.
- Put students into partnerships and distribute the claim strips and evidence cards.
- Explain that students will place their claim strips at the top of their work space. They will then sort the evidence cards according to which claim each piece of evidence supports, placing all of the evidence cards under the appropriate claim.
- Explain that the information on the cards can be used as ***evidence***: data, facts, or observations based on research or experience (point to this definition on the board).
- Be sure to tell your students that before they place a piece of evidence under a claim strip, they must discuss and agree on where it should go. (You may need to demonstrate this if you have not done many evidence sorts with students before.)
- Give students 8 minutes to sort and discuss.

Supporting your claim with evidence and reasoning (about 30 minutes)

- After all pairs have sorted, ask students to decide independently whether they think gravity is a strong or weak force.
- Explain to students that what they just decided on is a ***claim***: a tentative answer to a question (point to this definition on chart paper, post it). Explain that tentative means that it's an educated guess, and that it doesn't have to be your final answer.
- Emphasize that usually, they will have to come up with claims on their own, rather than choosing from two, but for today, they only have to pick. Tell them that scientists make claims all the time, but in most cases, they do so *only after* examining evidence. In addition, scientists often modify or change their claim as they examine additional new evidence.
- Ask students why they think that scientists wait until they have seen the evidence to develop a claim. Ask them about examples of times that people make claims without examining all the evidence, and why this is a problem.
- Tell students you want to give them another example.
- Tell students to imagine that you are trying to decide whether a certain plant fertilizer works. Before you decide what you think, you want to examine some evidence. You have gathered some information based on an experiment to help you determine your claim: the plants which we fed the fertilizer were three inches

taller, had 25% more leaves, and produced 15% more flowers than those who were fed with just water. (Write these examples below your definition of evidence.)

- As a class, work together to develop a claim about the fertilizer based on this evidence. It should be something like: The fertilizer makes plants healthier. Write this example under your definition of claim.
- Tell your students that in order to argue that the fertilized plants are healthier, I need to explain why my particular evidence actually supports my claim. I do this through reasoning. ***Reasoning*** is the explanation of why your evidence actually supports your claim (point to definition on chart paper, post it.) In this case, my reasoning might be something like: "Plant height, number leaves, and number of flowers are good measures of how healthy a plant is." That is, healthier plants are taller and have more leaves and flowers. (Write this example of reasoning on the board).
- Put the whole thing together: Explain that ***claim, evidence,*** and ***reasoning*** are the three parts of an argument.
- Now, return to the question about gravity. Instruct students to put together the three parts of their argument independently to support their claim about whether gravity is a strong or weak force. They should record this on the argument handout attached.
- Invite a few students to share their arguments.

Optional: testing your argument (about 30 minutes)

*Note: although this series of lessons is designed to support students who are struggling to develop claims, evidence, and reasoning independently, we have found that the culminating discussion pushes students to think more deeply about the validity of their claims, the strength of their evidence, and the rationality of their reasoning.

- **Introduce Discourse Circles.** Tell the class that they'll be using a routine called Discourse Circles to share their ideas about whether gravity is a strong or weak force based on the evidence they just read. During this activity, they'll get a chance to talk and listen in a group of four.
- **Explain the directions.** Explain the procedure for Discourse Circles, as follows:
    a. One person presents her position and her evidence.
    b. Other students who agree add their evidence
    c. Then a student who disagrees says why and presents his evidence.
    d. The group discusses the statements and evidence to see if they can come to agreement.
- **Model, if needed.** You can model with any topic (you might describe your favorite movie, book, what you did this weekend, etc). Choose three students to come to the front of the room and be your group. Go through the steps, being sure to use sentence starters (if you have previously taught these).
- **Pose the discussion question for partner one.** Ask, **"Is gravity a strong or weak force?"** Be sure to post the instructions somewhere visible, so that students can refer to them if they don't know what to do. If you anticipate that your

students will need more structure, you can use a timer and walk them through each step.

a. One person presents her position and her evidence.
b. Other students who agree add their evidence
c. Then a student who disagrees says why and presents his evidence.
d. The group discusses the statements and evidence to see if they can come to agreement.

*Students might ask: What if we all agree? If this is the case, ask one student to play the "devil's advocate." You might mention the origin of this phrase—it came from the Roman Catholic Church's process of canonizing someone: they had someone act as the Devil's advocate, explaining why they shouldn't be canonized. Explain the importance of disagreement in testing ideas.

Why this matters:

Discussion in which students are unable to support their claims with evidence and reasoning often fall flat. They have a tendency to become a sort of sharing circle where students merely state what they think one after another. However, when students are able to cite evidence and explain through reasoning why this evidence supports their claim, discussion participants have the raw materials needed to question, critique, and build on one another's ideas. When students learn that it is their job (and not the teacher, a textbook, or the internet's) to make sense of the world around them, they are empowered to think deeply about what they observe in order to develop their own theories.

Resources:

- Evidence cards
- Argument handout

Continued Teaching and Support:

Students who struggle to support claim with evidence, and reasoning could be doing so for a number of reasons. Ask yourself: Does this student comprehend the texts we read and the data we analyzed? If the answer to this is no, rather than teaching a targeted lesson on developing arguments, consider modifying the resources used, or playing a more active role in facilitating comprehension. However, if students continue to struggle with developing evidence and reasoning but demonstrate an understanding of the text and data involved, they may benefit from the type of explicit step-by-step instruction presented here. One time with one set of data might just simply not be enough. Modeling these skills (as is done in this lesson with the plant fertilizer example) is also helpful.