

Teachers who make use of well crafted writing tasks get students to reveal their thinking about science, understand more science, and improve their writing.

Additionally, the teachers get more enjoyment out of teaching.

Designing Writing Tasks for the NGSS Classroom

Constructing explanations, arguing from evidence, and communicating information are central features of scientific discourse. Writing in science classes should reflect these practices.

Arthur Beauchamp - UC Davis
acbeauchamp@ucdavis.edu
<http://sasp.ucdavis.edu>



First, A SURVEY

Consider your students' ability to express their understanding of science concepts in writing, explain natural phenomena, and write scientific arguments based on evidence.



G.A.N.D.H.I. HAPPINESS METER

Set up a piece
of paper or
document as
shown.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7.

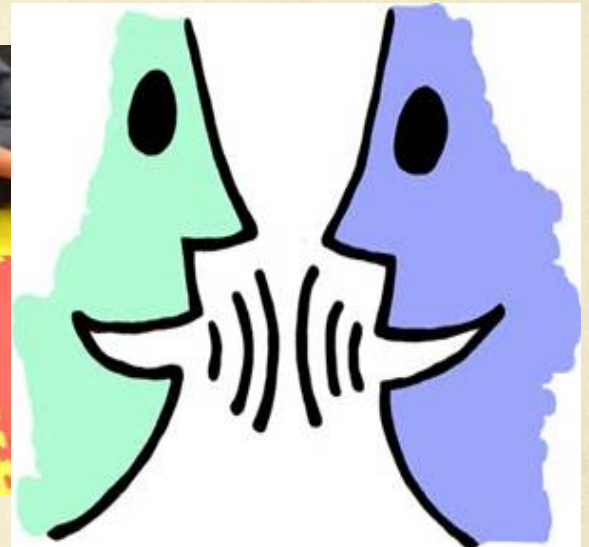
Think – my thoughts
at this time

Pair – what I understand
my partner is telling me

Share – our common understanding or questions
that we can share

Interactions

We will be interacting with one another



Find a partner and take turns introducing yourselves

You have 30 seconds

RETURN

- Time is up.
- Thank your partner.
- Return your attention to the front.

Taking Science to School (NRC, 2007) -

describes science as a social phenomenon, in which a community of peers pursues shared objectives and abides by shared conventions that shape their work.

- In other words, people (and students) engage in science by sharing ideas, theories, and models; by collecting and analyzing data; by constructing and critiquing arguments; and by using specialized ways of talking and writing.

Writing is important to what scientists do

“I think that anyone who gets into science as a whole and doesn't understand that they are becoming a writer is fooling themselves, because a large part of the success in science relates directly to one's ability to convey that information to other people, and that is a huge part of doing science.”

Jake Harwood, Department of Communication at the University of Arizona, quoting a scientist in a study investigating perception and communication

NGSS and writing in Science

Engage in Argument from Evidence

- 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.
- Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system...
- Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

NGSS and writing in Science

Obtaining, Evaluating, and Communicating Information

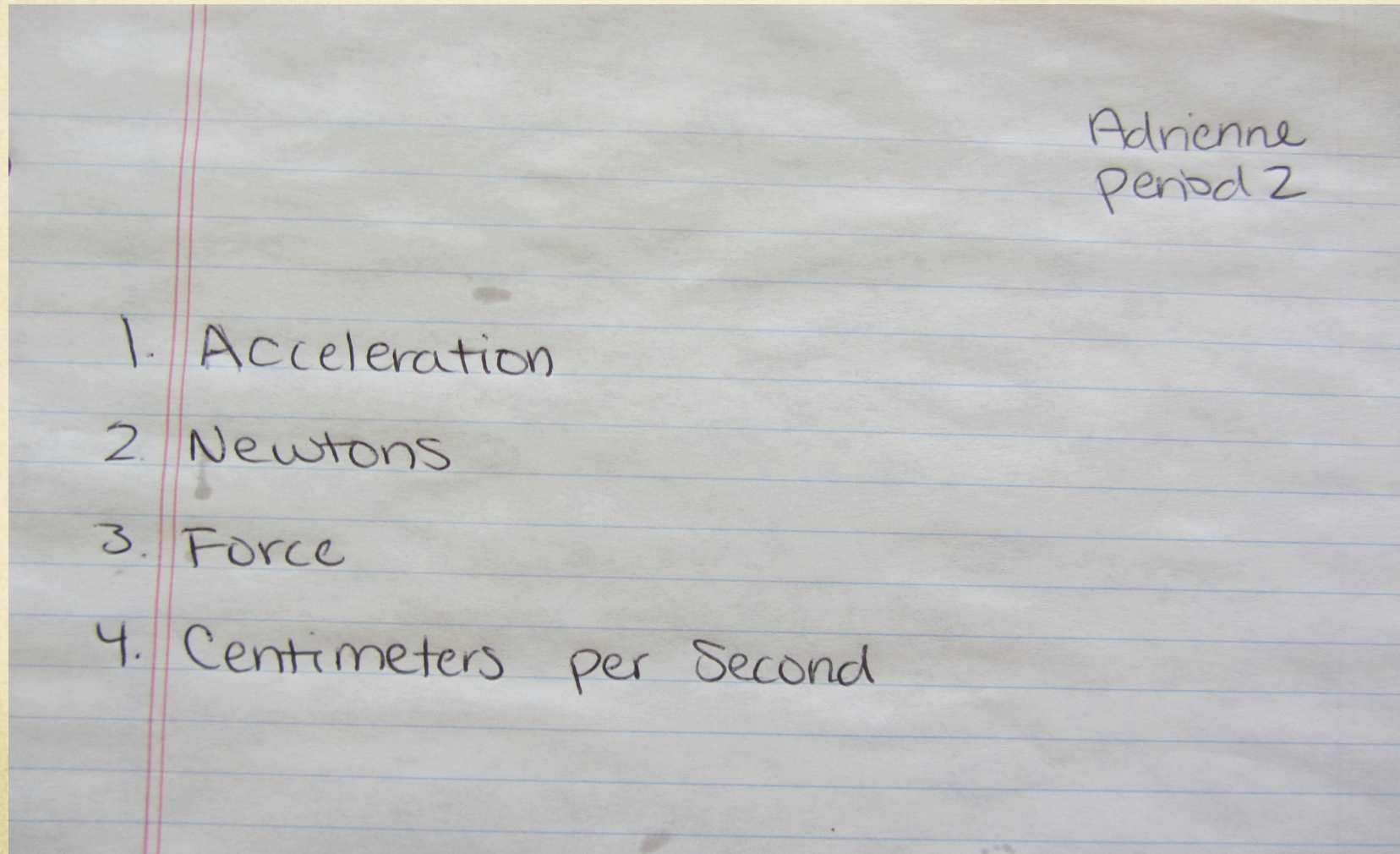
- Being able to read, interpret, and produce scientific and technical text are fundamental practices of science and engineering, as is the ability to communicate clearly and persuasively
- Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing

From Common Core –

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately.

What does student writing look like now?

Might it look something like this?



Or like this?

Danielle
period 3

1. The three major types of plate boundaries are convergent, divergent and transform.
2. The Hawaiian Islands are built from a hot spot in the earth's crust.
3. Most large earthquakes happen along fault lines.

Or like this?

Ryan



Our hypothesis was wrong. The experiment showed that ice floats higher in ~~the~~ salt water.

Conclusion:

In our lab the ball rolled up then down. The forces made it do this.

Typical Science Writing Tasks

- What are 3 types of body coverings on animals?
- What instinct do Monarch butterflies have?
- Name four things that plants need to live.
- Which part of roots take in nutrients for plants?
- In most ecosystems, what kinds of organisms are producers?
- Give two reasons why populations of organisms decline.
- What does a mirror do?

RETURN

- Time is up.
- Thank your partner.
- Return your attention to the front.

More Science Writing Tasks

- Do more complex organisms always have more chromosomes than simpler organisms?
- Why must chromosomes be copied before cells divide?
- How is ATP involved in cellular respiration?
- Summarize how energy is made available by chemical reactions.
- What four factors affect how much damage is caused by an earthquake?
- List three reasons why soil is important.

RETURN

- Time is up.
- Thank your partner.
- Return your attention to the front.

I'm not an English teacher

- ...except of course, the elementary teachers, who ARE reading and writing teachers
- Secondary English teachers tend to teach literature and creative writing
- Writing in the disciplines is too often neglected
- So, who is going to help kids learn how to write science if not you?

Considerations for Writing

- Dialogue sets up and supports writing
- Informal writing precedes formal writing (scaffolding)
- Give a worthy task – involve sense-making or choice – activate stance (focus on phenomena, work from data, embrace ambiguity)

Focus on Phenomena

- Phenomena are things people observe in the natural world
- Once we observe a phenomena our tendency is to try to explain it or make sense of it

Consider the images on the left and on the right –
what do you notice about the light?
Why do you think this happens?



RETURN

- Time is up.
- Thank your partner.
- Return your attention to the front.

Anticipatory Set

For each of the following statements, individually respond and put an A where you agree and a D where you disagree.

You have 1 minute

1. Leaves have veins in them.
2. Leaves are green only on their surface (outside).
3. A thick leaf will catch more sunlight than a thin leaf.
4. Sunlight actually goes part way into leaves.
5. Chloroplasts move from leaves to roots carrying food.
6. Leaves have holes in them that can open and close.
7. All plants make sugar.

Partner Dialogue

Have a conversation with your partner about your thinking. You have 2 minutes.

1. Leaves have veins in them.
2. Leaves are green only on their surface (outside).
3. A thick leaf will catch more sunlight than a thin leaf.
4. Sunlight actually goes part way into leaves.
5. Chloroplasts move from leaves to roots carrying food.
6. Leaves have holes in them that can open and close.
7. All plants make sugar.

RETURN

- Time is up.
- Thank your partner.
- Return your attention to the front.



LEARN ABOUT

How Plants Make Food

FIND OUT

- about the structure of leaves
- how plants make and use food
- how energy from food supports different life forms

VOCABULARY

photosynthesis
epidermis
palisade layer
cellular respiration

A cornfield is like a factory, turning raw materials (water and carbon dioxide) into finished products (food and oxygen). ▼



Leaf Structure

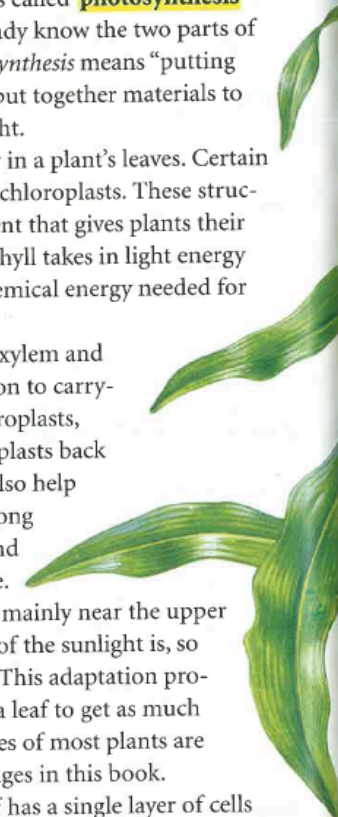
You may remember that plants make their own food by using water, carbon dioxide, chlorophyll, and sunlight. The process by which plants make food is called **photosynthesis** (foh•toh•SIN•thuh•sis). You may already know the two parts of this word. *Photo* means “light” and *synthesis* means “putting together.” In photosynthesis, plants put together materials to make food with the energy of sunlight.

Photosynthesis takes place mainly in a plant’s leaves. Certain cells in a leaf have most of the leaf’s chloroplasts. These structures contain chlorophyll, the pigment that gives plants their green color. During the day, chlorophyll takes in light energy from the sun and changes it into chemical energy needed for photosynthesis.

Most leaves also have a system of xylem and phloem tubes called veins. In addition to carrying water from the roots to the chloroplasts, veins carry food made in the chloroplasts back to the stem and roots. Veins also help keep leaves from wilting. As long as its veins are full of water and food, a leaf will keep its shape.

Photosynthesis takes place mainly near the upper surface of a leaf, where most of the sunlight is, so most leaves are thin and flat. This adaptation provides a large surface area for a leaf to get as much sunlight as possible. The leaves of most plants are not much thicker than the pages in this book.

The upper surface of a leaf has a single layer of cells that protects the inner cells in much the same way your skin protects your inner cells. This layer is called the upper **epidermis** (ep•uh•DER•mis). The epidermis is thin and flat, and sunlight easily passes through it.



On the following slide is a graph of the deer population on the Kaibab Plateau in northern Arizona over a period of 34 years

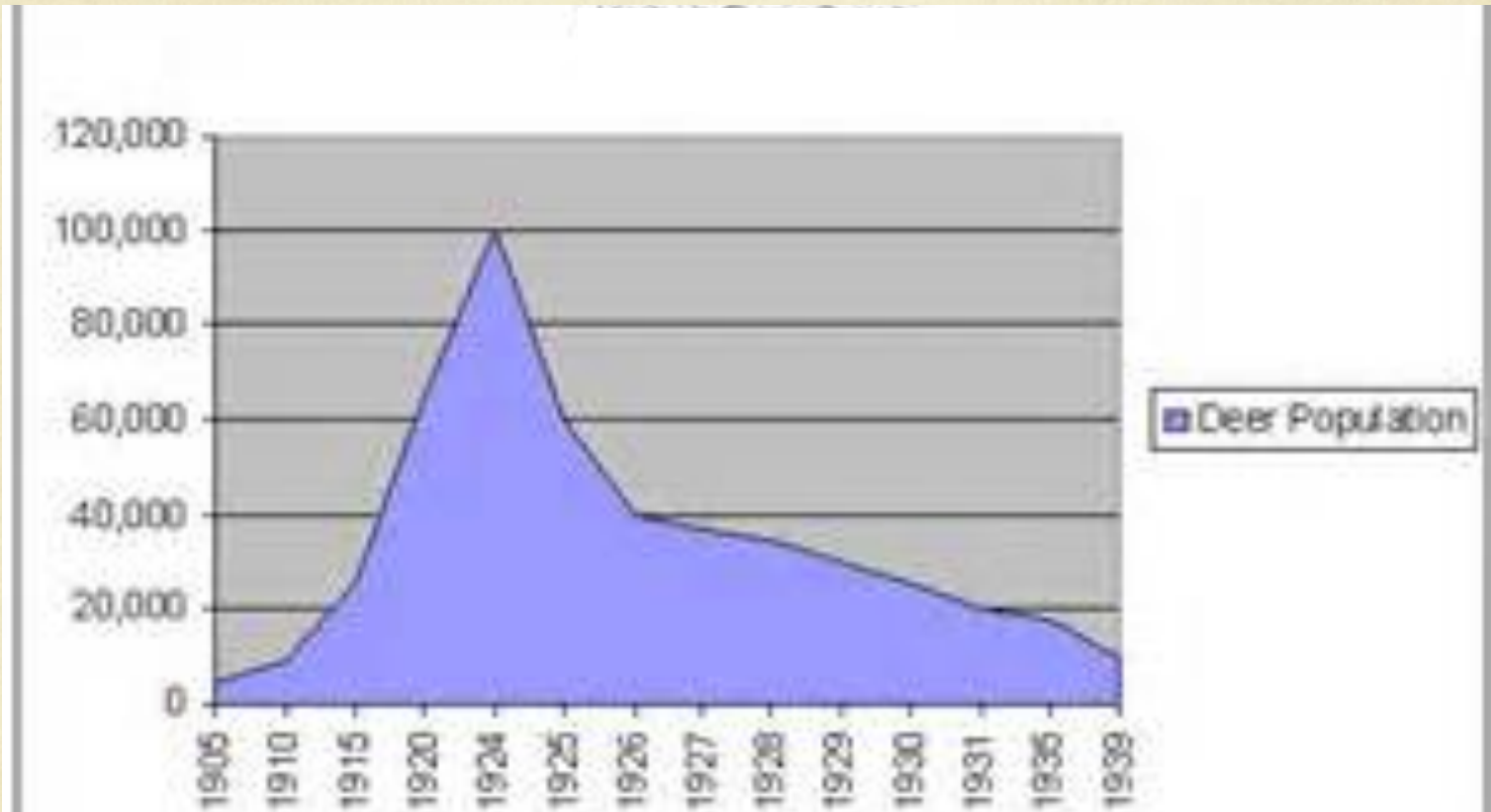
Individually write:

- A) what you think the graph shows you, and
- B) a reason why you think this may have happened.

Do this in the Think box.

You have 2 minutes

Kaibab Plateau Deer Population 1905 - 1939

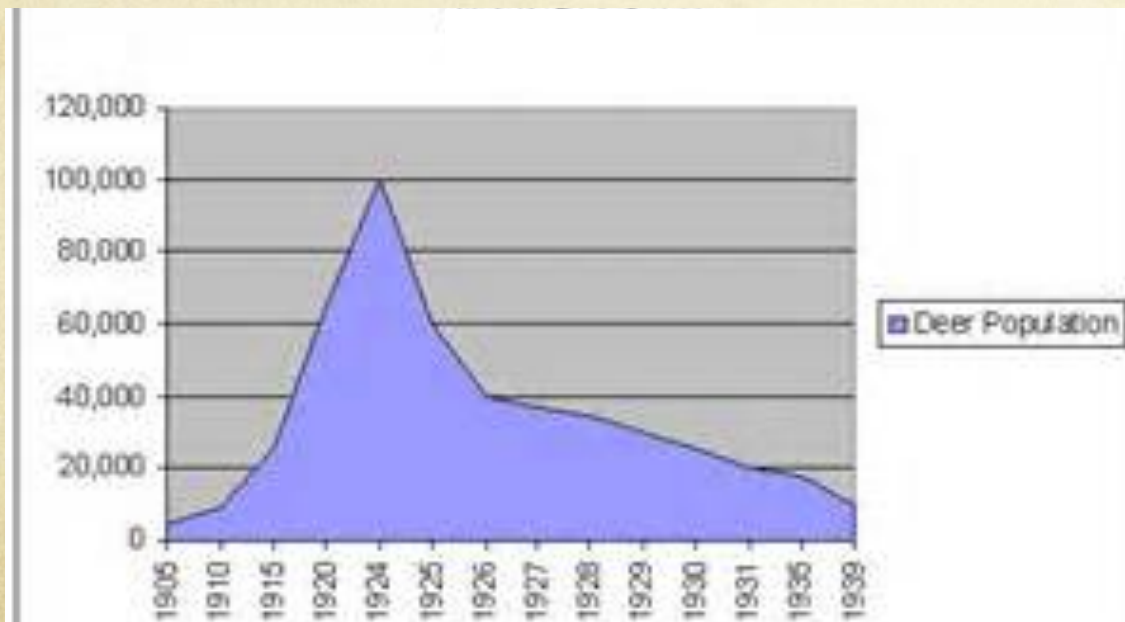


What does the data tell you about the deer population?
Why do you think this might have happened?

Kaibab Plateau Deer Population

Once you and your partner have written your thinking have a brief conversation in which you share and summarize each other in the “Pair” box.

You have 3 minutes



RETURN

- Time is up.
- Thank your partner.
- Return your attention to the front.

STRUCTURED THINK - PAIR - SHARE

My name: _____ Partner's name: _____

Think – my thoughts or understanding at this time.

Pair – what I understand my partner is telling me.

Share – our common understanding after talking, what we can share with others or what was most important from our dialogue (can be understandings, questions, wonderings, etc.).

Challenge Statements

- Challenge Statements are carefully crafted prompts that employ an appropriate amount of ambiguity or choice.
- They are a statement, not a question.
- Challenge Statements invite responders to agree, disagree or fall somewhere in between.
- The full Challenge Statement includes the statement, the directions and a chance to revise ones thinking via dialogue with others.

Challenge Statement

- Genetic variation is more important than environmental influences in natural selection.

DIRECTIONS – Consider the statement above.

You might agree, disagree, or be somewhat in between. Write a response explaining your thinking about the statement. Please limit your technical vocabulary. If you need to use scientific terms be sure to explain what you mean.

Sample Challenge Statements

- ATP is the most important molecule for cells.
- The most critical phase of mitosis is metaphase.
- Fossils are the main evidence for plate tectonics.
- Water is more dense than ice because water molecules are smaller than ice molecules.
- If you had a helium balloon on the moon it would not float.
- Very large stars are more red than yellow.
- Gravity works in one direction.

Sample Challenge Statements

- Any metal will conduct electricity.
- If the water on land becomes polluted we can just use the water from the ocean as long as we take the salt out.
- Earthquakes are more dangerous than tsunamis.
- Mechanical weathering takes place before chemical weathering.
- In glaciers all the types of moraines are essentially the same.

Partners

- Talk with your partner about Challenge Statements
 - Your understanding after seeing them
 - How you might use them

You have 1 minute



RETURN

- Time is up.
- Thank your partner.
- Return your attention to the front.

Novice to Expert Response

1. Don't believe that persistent analysis is essential, therefore effort and motivation to persist is weak.
2. Careless in their reasoning.
3. Don't break tasks into component parts and go step-by-step, therefore there are more errors.
4. Focus on individual details, and don't see how details relate to concepts, therefore, every concept feels new (overwhelming).
5. Formula-memorizing is a main strategy.
6. Often get behind in learning, and then sequential learning is hampered.
7. Loss of confidence in ability to achieve due to lack of success.

The Communication Triangle

Text Format:
essay, news
article, letter

Writer/Perspective:

Who is speaking?

Reader/Audience:

**Who are you
speaking to?**

RAFT = Reader, Audience, Form, Topic

Applying the Communication Triangle

- You are a wildlife biologist working in Arizona. Another biologist makes the statement that “the Kaibab deer population has changed in line with availability of forage” so the population must be at a point of equilibrium with the environment.

Write a letter to your colleague either agreeing or disagreeing with him. In your letter, make sure you support your position with evidence from the data, from text sources and from your own thinking.

Applying the Communication Triangle

- You are a geologist studying rocks to determine the direction of flow of an ancient glacier. What clues might help you determine the glacier's direction of flow? Put your answer in the form of a "Do-It-Yourself" guide to determining glacial flow direction.
- You are a doctor with a patient who has a condition in which some harmful molecules are getting into their cells. Write an email to them that explains how a cell membrane is structured to keep some molecules out and let others in.



Science Writing

○ You, Peter, and Sonja are going to the mall. As you approach, you see the sight below. Peter says, “we can see the light beams because they are blue light on a dark background.” Sonja says, “No, we see the light beams because particles in the air scatter the light in all directions.”

○ Which friend do you agree with?

Give a detailed account of your reasoning and provide evidence to support your reasoning for your friend.



What is Light?

Day 1 (beginning of the period, start of a new unit)

PROMPT: We've spent the last few weeks studying various kinds of waves - for example, waves on a slinky, water waves, and sound waves. Now think about LIGHT. Some people say that light is made of waves. What do you think? Is light really made of waves, or do people say it is waves because they don't know what else to say? Explain what you think, even if you are not sure. It is OK to guess.

Well since we're studying waves then light I'm assuming there is some connection. I always thought of light as a kind of ray. I have been told that light is a wave and a particle but I don't know how that works. If it is a particle why don't we see spots of it around?

Day 1 (about 10 minutes later in the class period)

PROMPT: Now let's think about the evidence. Think of some behaviors of light (things light can do or things it cannot do).

- a) What evidence can you think of, if any that supports the idea that light is made of waves?
- b) What evidence can you think of, if any that supports the idea that light is NOT made of waves?

- a) - Light reflects off of mirrors and other shiny surfaces.
 - I can see refraction in water (because of light).
 - Light can go through some materials but not others.
 - Lenses (concave/convex) change how we see things.
- b) I've never seen an individual light wave.
 - Why don't things shake when light goes by?

Day 4 (after a few days of studying phenomena and discussing two different models of light)

PROMPT: Think about all the behaviors of light we have observed over the past couple of days. At this moment, what do you think about the question of light: Is it really made of waves? Does the evidence support this claim? Or do you think the evidence supports the other claim better, that light is a spray or beam of particles? Explain your thinking.

Light exhibits several behaviors that support the particle theory. We know that light travels from the sun to Earth through space, a vacuum. Since a wave needs matter to oscillate (and there is no matter in space), light cannot be a wave.

Furthermore, light does not cancel out other light. Two waves meeting crest to ~~crest~~ trough would cancel each other out, but light does not do this.

Light does reflect and refract as do waves, but particles are capable of these motions as well as waves.

We see a spectrum of light intensities and colors but this can be due to different particle intensities rather than wave frequencies.

Day 5 (beginning of the class period; the previous day students had studied more phenomena)

PROMPT: At this moment, which model or claim about light do you think is best supported by the evidence - the wave model or the particle model? What is your reasoning?

At this moment I think that light is a wave. It follows the same rules when reflecting, refracting, and diffracting. Seeing as there is so much similarity between the way that both light and waves act, I think it is most probable that light is a special type of wave. This seems much more reasonable than the idea that light is made of particles.

Day 5 (end of the class period, after students investigated more phenomena)

PROMPT: You just collected some more observations about light. Now, what do you think about the claim that light is made of waves?

Now, I am starting to ~~doubt~~ doubt my previous view, I would say that I am on the fence.

I did not think particles could ~~reflect~~ refract like light. The particle idea is starting to make more sense.

Day 6 (after students investigated more phenomena)

PROMPT:

- a) What behavior of light would you say is the greatest argument against the claim that light is made of waves?
- b) Can you think of a way to explain how light can do this behavior? Can it do this behavior and still be made of waves, or does it need to be something else? Explain your thinking.

a) How light travels through a vacuum.

b) If light were a wave, it would need a medium to go through, so I'm guessing it is also a particle in a way.

Light might be able to bring its own particles into a vacuum and then send waves of motion through itself to travel in the space.

Thank You

Writing tools and other resources can be found at –
<http://sasp.ucdavis.edu>

Science
teacher
humor

acbeauchamp@ucdavis.edu

