

Teaching Argumentation in an Introductory ESL Science Classroom

Take a quick survey while you're waiting:
<https://goo.gl/7BNXkJ>

Patrick Baldwin
Maine East HS
Park Ridge, Illinois



Mon-Lin Ko
University of Illinois
at Chicago



Link to Presentation
<https://goo.gl/57K5NR>



@MistaBaldwinM

PROJECT **READi**

Reading, Evidence, and Argumentation in Disciplinary Instruction

PROJECT READI is a multidisciplinary, multi-institution collaboration aimed at research and development to improve complex comprehension of multiple forms of text in literature, history and science.

The research reported here was supported, in part, by the Institute of Education Sciences, U.S. Department of Education, through Grant R305F100007 to University of Illinois at Chicago. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.”



Sorry, no Monica

She's got more important
things going on!



العربية

ગુજરાતી

മലയാളം



اردو



Créole haïtien Український

Planning Argument Based Instruction

Content comes from:

Skills come from:



Have a place to choose both from.



for assessments!

What goes through my mind while planning?



- What's the argument you want your students to make?



- What data do they need to make an evidence based (reasoned) argument?

Data sets? Readings? Models? Etc.

- What skills do you want them to work on while reading or engaged with text?



- How are you going to get them to make a reasoned argument?
- What are you going to have them do at the end for a consequential task?

What's the argument you want your students to make?



- Gives you the basis for your argument
- Foundation of our beloved CONTENT!

Here's an example:

HS-ESS 1.6

Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

How do you think the
Moon formed?



What's the argument you want your students to make?

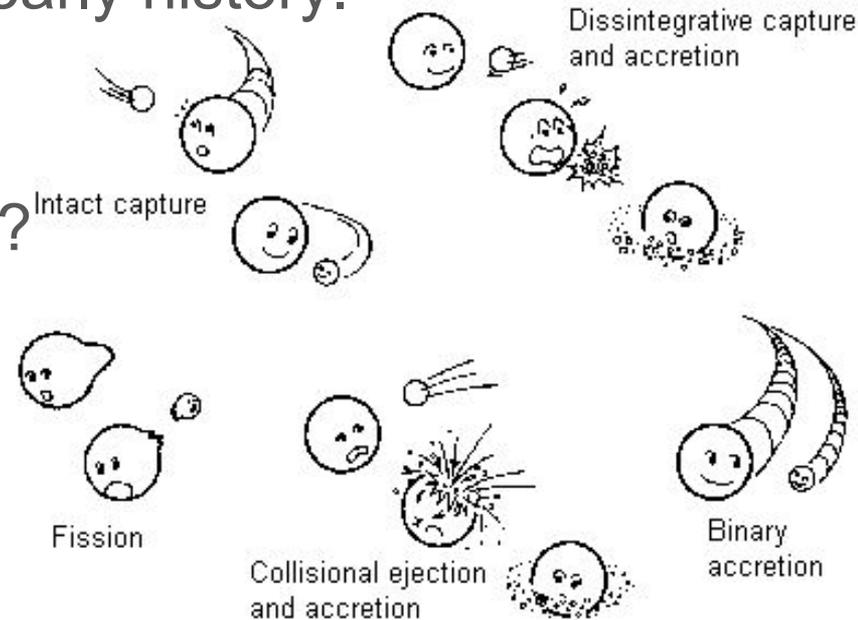


Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

My argument:

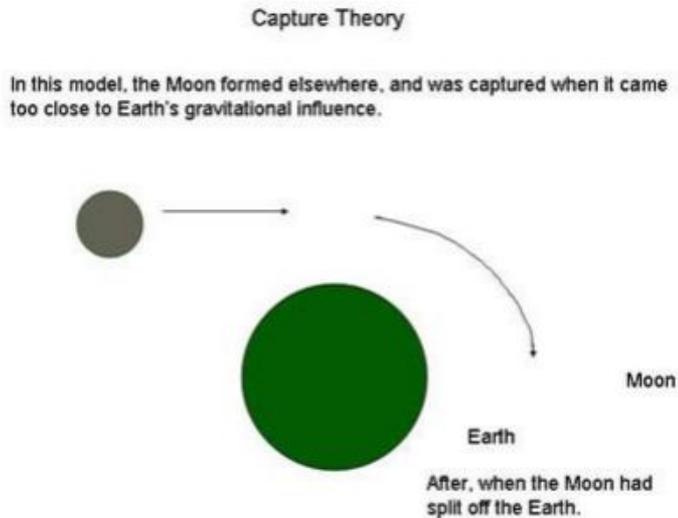
How do you think the Moon formed?

1. Their own hypothesis
2. [Other Hypotheses](#)
3. Their edited hypothesis



Capture Hypothesis

In 1909 an astronomer named Thomas See proposed that the moon was a wandering planet that had been captured by the Earth. The moon got too close to the planet Earth and was pulled into an orbit based on the Earth's gravitational pull "like a fly in a spider web".



	Capture	Collision	Co- accretion	Fission	Your Hypothesis
Summary of hypothesis					

[Data table for students](#)

Based on their hypotheses and the others

What data would we need to support these hypotheses?

What would need to be true to support this hypothesis?

What data could refute this hypothesis?

What experimental data exists to support/refute this hypothesis?

What data do they need to make an evidence based / reasoned argument?

How do we know what we know?



to support the leading hypothesis AND
to refute the other hypotheses

Moon example:

What data do we have that supports our best understanding of how the moon formed?

What types of texts do I need to build?

Moon example:

- Length of day getting longer
- Density patterns of planets
- Layers of the planets
- Size of our moon relative to planet
- Composition of bodies
- Oxygen isotope analysis

Notice ... Little to no Textbook!

Why not?

Easier!

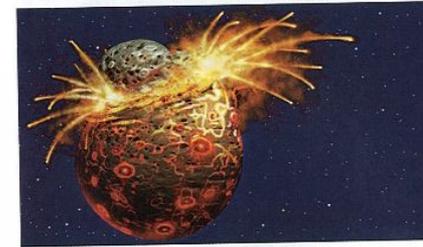
Less time!

The Giant Impact Hypothesis

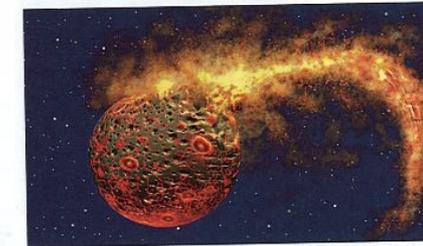
Most scientists think that the moon's development began when a large object collided with Earth more than 4 billion years ago. This *giant impact hypothesis* states that a Mars-sized body struck Earth early in the history of the solar system. Before the impact, Earth was molten, or heated to an almost liquid state. The collision ejected chunks of Earth's mantle into orbit around Earth. The debris eventually clumped together to form the moon, as shown in **Figure 6**.

Most of the ejected materials came from Earth's silica-rich mantle rather than from Earth's dense, metallic core. This hypothesis explains why moon rocks share many of the chemical characteristics of Earth's mantle. As the material clumped together, it continued to revolve around Earth because of Earth's gravitational pull.

Figure 6 The First Stage of Moon Formation



Scientists think that a Mars-sized object collided with Earth and blasted part of Earth's mantle into space.



The resulting debris then began to revolve around Earth.



The material eventually joined to form Earth's moon.

A second makes a world of difference

By Bill Scanlon

Rocky Mountain News Staff Writer

BOULDER — At 5 p.m. New Year's Eve, a second will be added to the atomic clock here to slow it into synch with Earth's rotation.

Budget agreement or not, a physicist and a computer programmer from the National Institute for Standards and Technology in Boulder will be on hand Sunday when the world's clocks add a second.

Five o'clock here is midnight on the last day of the year, Greenwich, England, time. The official last minute of the year will be 61 seconds long.

Earth's rotation is slowing ever so slightly every year. In addition, the measure of a second — 9.193 billion oscillations of the cesium atom — wasn't quite precise when that became

the official standard in 1967, said Judah Levine, physicist with NIST in Boulder.

So, every year or year-and-a-half, on Dec. 31 or June 30, the world's most accurate clocks add a second — called a leap second.

"The Earth and the clock get out of synch. We live by the Earth, and the Earth doesn't care one whit what the atom is doing," said Don Sullivan, chief of the time and frequency division at NIST in Boulder.

Although the leap second is needed mostly to adjust to imperfections in the atomic clock, and only marginally to adjust to a decelerating Earth, those seconds add up over time. Scientists at Australia's Adelaide University believe the Earth day was just 23 hours long at the time of the dinosaurs.

Levine and computer programmer Trudi Pepler are two of the handful of

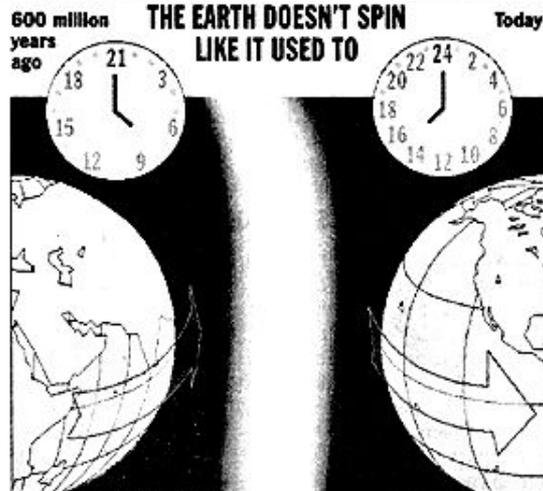
NIST employees working through the federal-government furlough. Chances are slim that anything would go wrong with the atomic clock if no one monitored it the next few days. There are batteries, generators and several back-up clocks to keep things humming.

But, lo, what a catastrophe if the fail-safe system failed:

■ Navigators and geologists rely on the atomic clock for precise positioning. By measuring the time it takes a signal traveling at the speed of light to reach a satellite, an object's exact location can be determined.

■ Without the atomic clock, long-distance phone calls and other telecommunications that use bands of optic fiber would be slowed or garbled.

"If clocks are synchronized, we can get a lot more information through the noise," Sullivan said.



Days have been getting longer. Geologists speculate that more than 600 million years ago a day was just 21 hours. Partly because the earth is rotating more slowly, the world's time experts will add a 'leap second' to the end of 1995.

Source: Adelaide University / National Institute of Standards & Technology. Graphic, Rocky Mountain News

1st TITLE

Newspaper?

time? first/second?

A second makes a world of difference

By Bill Scanlon

Rocky Mountain News Staff Writer

BOULDER — At 5 p.m. New Year's Eve, a second will be added to the atomic clock here to slow it into synch with Earth's rotation.

Budget agreement or not, a physicist and a computer programmer from the National Institute for Standards and Technology in Boulder will be on hand Sunday when the world's clocks add a second. longer days

Five o'clock here is midnight on the last day of the year, Greenwich, England, time. The official last minute of the year will be 61 seconds long.

Earth's rotation is slowing ever so slightly every year. In addition, the measure of a second — 9.193 billion oscillations of the cesium atom — wasn't quite precise when that became

the official standard in 1967, said Judah Levine, physicist with NIST in Boulder.

So, every year or year-and-a-half, on Dec. 31 or June 30, the world's most accurate clocks add a second — called a leap second.

"The Earth and the clock get out of synch. We live by the Earth, and the Earth doesn't care one whit what the atom is doing," said Don Sullivan, chief of the time and frequency division at NIST in Boulder. Not perfect?

Although the leap second is needed mostly to adjust for imperfections in the atomic clock, and only marginally to adjust to a decelerating Earth, those seconds add up over time. Scientists at Australia's Adelaide University believe the Earth's day was just 23 hours long at the time of the dinosaurs.

Levine and computer programmer Trudi Pepler are two of the handful of

NIST employees working through the federal-government furlough. Chances are slim that anything would go wrong with the atomic clock if no one monitored it the next few days. There are batteries, generators and several back-up clocks to keep things humming.

But, lo, what a catastrophe if the fail-safe system failed:

■ Navigators and geologists rely on the atomic clock for precise positioning. By measuring the time it takes a signal traveling at the speed of light to reach a satellite, an object's exact location can be determined.

■ Without the atomic clock, long-distance phone calls and other telecommunications that use bands of optic fiber would be slowed or garbled.

"If clocks are synchronized, we can get a lot more information through the noise," Sullivan said.

2ND

BEFORE = 21 hr/day

Now = 24 hr/day

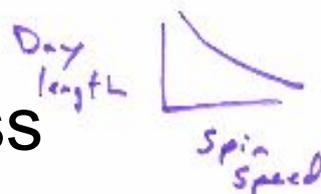


Days have been getting longer. Geologists speculate that more than 600 million years ago a day was just 21 hours. Partly because the earth is rotating more slowly, the world's time experts will add a "leap second" to the end of 1995.

Source: Penn State University; National Institute of Standards & Technology. Graphic: Rocky Mountain News

leap second: +1 sec
leap year: +1 day

Longer days = slower spin!



Adapted From: <http://www.enterprisemission.com/hyper3.html>

This is how I model in front of the class

The Length of the Day: A Cosmological Perspective

Arbab I. Arbab

*Department of Physics, Faculty of Science, University of Khartoum, P.O. 321, Khartoum 11115, Sudan
and Department of Physics and Applied Mathematics, Faculty of Applied Sciences and Computer,
Omdurman Ahlia University, P.O. Box 786, Omdurman, Sudan*

E-mail: aiarbab@uofk.edu; arbab_ai@yahoo.com

We have found an empirical law for the variation of the length of the Earth's day with geologic time employing Wells's data. We attribute the lengthening of the Earth's day to the present cosmic expansion of the Universe. The prediction of law has been found to be in agreement with the astronomical and geological data. The day increases at a present rate of 0.002 sec/century. The length of the day is found to be 6 hours when the Earth formed. We have also found a new limit for the value of the Hubble constant and the age of the Universe.

Time*	65	136	180	230	280	345	405	500	600
solar days/year	371.0	377.0	381.0	385.0	390.0	396.0	402.0	412.0	424.0

* Time is measured in million years (m.y.) before present.

Table 1: Data obtained from fossil corals and radiometric time (Wells, 1963 [6]).

Time*	65	136	180	230	280	345	405	500	600
solar days/year	370.9	377.2	381.2	385.9	390.6	396.8	402.6	412.2	422.6
length of solar day (hr)	23.6	23.2	23.0	22.7	22.4	22.1	21.7	21.3	20.7
Time*	715	850	900	1200	2000	2500	3000	3560	4500
solar days/year	435.0	450.2	456.0	493.2	615.4	714.0	835.9	1009.5	1434.0
length of solar day (hr)	20.1	19.5	19.2	17.7	14.2	12.3	10.5	8.7	6.1

* Time is measured in million years (m.y.) before present.

Table 2: Data obtained from our empirical law: equations (9) and (10).

Science Abstracts

- Still within reach of ESL students
- Does this agree with the last text?

1st → Title

The Length of the Day: A Cosmological Perspective

Arbab I. Arbab

Department of Physics, Faculty of Science, University of Khartoum, P.O. 321, Khartoum 11115, Sudan
and Department of Physics and Applied Mathematics, Faculty of Applied Sciences and Computer,
Omdurman Ahlia University, P.O. Box 786, Omdurman, Sudan

E-mail: aiarbab@uofk.edu; arbab_ai@yahoo.com

3rd

We have found an empirical law for the variation of the length of the Earth's day with geologic time employing Wells's data. We attribute the lengthening of the Earth's day to the present cosmic expansion of the Universe. The prediction of law has been found to be in agreement with the astronomical and geological data. The day increases at a present rate of 0.002 ^{Rate} sec/century. The length of the day is found to be 6 hours when the Earth formed. We have also found a new limit for the value of the Hubble constant and the age of the Universe.



More days = Faster Spin

OLDEST

2nd Data Table

NOW

371 Days in a Year

Time*	65	136	180	230	280	345	405	500	600
solar days/year	371.0	377.0	381.0	385.0	390.0	396.0	402.0	412.0	424.0

*Time is measured in million years (m.y.) before present.

424 Days in a Year!

Table 1: Data obtained from fossil corals and radiometric time (Wells, 1963 [6]).

Time*	65	136	180	230	280	345	405	500	600
solar days/year	370.9	377.2	381.2	385.9	390.6	396.8	402.6	412.2	422.6
length of solar day (hr)	23.6	23.2	23.0	22.7	22.4	22.1	21.7	21.3	20.7
Time*	715	850	900	1200	2000	2500	3000	3560	4500
solar days/year	435.0	450.2	456.0	493.2	615.4	714.0	835.9	1009.5	1434.0
length of solar day (hr)	20.1	19.5	19.2	17.7	14.2	12.3	10.5	8.7	6.1

*Time is measured in million years (m.y.) before present.

Table 2: Data obtained from our empirical law: equations (9) and (10).

Planet	Mass (Earth Masses)	Radius (Earth Radii)	Density gm/cm ³
Mercury	0.055	0.38	5.5
Venus	0.815	0.95	5.2
Earth	1.000	1.00	5.5
Mars	0.107	0.53	3.9
Jupiter	318	10.8	1.4
Saturn	95	9.0	0.7
Uranus	14.5	3.93	1.3
Neptune	17.2	3.87	1.6
Pluto	0.002	0.178	2.1

How do I handle various text types differently?

1 claim

1 surprise

1 question

Adapted From: <http://astronomy.nmsu.edu/tharriso/ast105/Ast105week06.html>

Moon	Mass (Earth Masses)	Radius (Earth Radii)	Density gm / cm ³
The Moon	0.0012	0.27	3.34

- I model one
- They do one with a partner

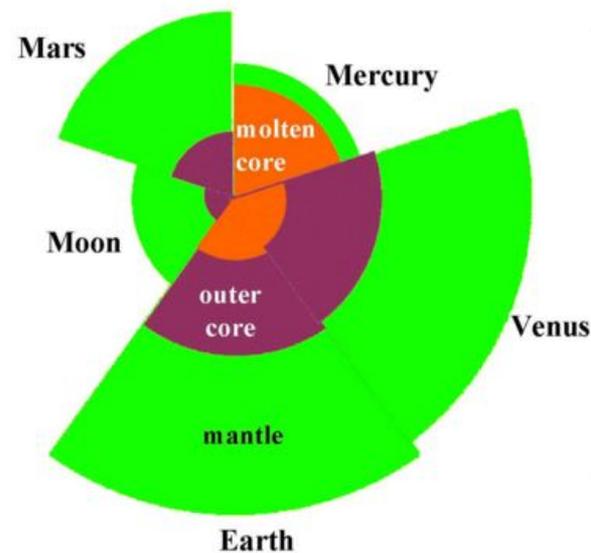
Layer structure of the inner terrestrial bodies

Adapted From: <http://ircamera.as.arizona.edu/NatSci102/NatSci102/lectures/earth.htm>

The interiors of the other terrestrial planets are similar to that of the earth, although Mars has cooled so far that its core is no longer molten. The composition of the moon is similar to that of the crust of the earth, and any formerly molten core has also cooled and solidified. In general, small bodies cool more quickly than large ones because there is less material around their cores to trap the heat of their formation. See picture below for the cross sections of the terrestrial inner bodies.

The core of the Moon comprises roughly 2-4% of the Moon's total mass, while the core of the Earth comprises roughly 32% of the overall mass of the Earth.

Adapted From: <http://www.enchantedlearning.com/subjects/astronomy/moon/Mooninside.shtml>



Elemental abundances of Earth's layers and the Moon.

Element	Earth's Crust	Earth's Mantle	Earth's Core	Earth Overall	Moon Overall
Iron (Fe)	5.6%	5.8%	85.5%	34.6%	3.5%
Oxygen (O)	46.1%	44.8%	0.0%	29.5%	60.0%
Silicon (Si)	28.2%	21.5%	6.0%	15.5%	16.5%
Magnesium (Mg)	2.3%	22.8%	0.0%	12.7%	3.5%
Titanium (Ti)	0.56%	0.13%	0.0%	0.05%	1.0%

Adapted From

McDonough, W. F. "Compositional Model for the Earth's Core." pp. 547–568 in *The Mantle and Core*. Edited by Richard W. Carlson. Oxford: Elsevier Ltd., 2005.

Gravity - Mass Attracts Mass

The general idea of gravity can be simplified into a few simple equations. The one most people know describes Newton's universal law of gravitation:

$$F = \frac{Gm_1m_2}{r^2}$$

where:

F is the force due to gravity, between two masses (m_1 and m_2), which are a distance r apart;
G is the gravitational constant.

From this is it straightforward to derive another, common, gravity equation, that which gives the acceleration due to gravity, g , here on the surface of the Earth:

$$g = \frac{GM}{r^2}$$

Planet Name	Ratio of Planet Mass to Moon Mass
Mercury	0.0 (no moons)
Venus	0.0 (no moons)
Earth	0.0122
Mars	0.00000002
Jupiter	0.00021
Saturn	0.00025
Uranus	0.00017
Neptune	0.00130

Data obtained from various Wikipedia pages.

What skills do you want them to work on while reading?

- Needs of students
- PLT goals
- How they fit the text



Fresh ESL group

CCSS.ELA.RST.9-10.1

Cite specific textual evidence to support analysis of science and technical texts

- Precise details

CCSS.ELA.RST.9-10.2

Determine the central ideas or conclusions of a text

Provide an accurate summary of the text

Junior Transitional

Cite specific textual evidence to support analysis of science and technical texts

- Gaps & Inconsistencies

Determine the central ideas or conclusions of a text

Paraphrase in simpler but still accurate terms

Metacognitive Bookmark

Metacognitive Bookmark

Predicting

I predict...

In the next part I think...

I think this is...

Visualizing

I picture...

I can see...

Questioning

A question I have is...

I wonder about...

Could this mean...

Making connections

This is like...

This reminds me of...

Identifying a problem

I got confused when...

I'm not sure of...

I didn't expect...

Using fix-ups

I'll reread this part...

I'll read on and check back...

Summarizing

The big idea is...

I think the point is...

So what it's saying is...

Citing Evidence

In the text/article/passage/report it said ...

An example is ...

The author states that ...

The graphic/photograph/chart/table shows that ...

According to the text/article/passage/report ..

... This disproves ...

The text also cites ...

... This supports ...

In addition, that author also writes ...

... this does not support ...

On page/paragraph ... it states that ...

... This demonstrates ...

... this refutes ...

How are you going to get them to pick a side?



Each new text set

SUPPORT

REFUTE

INCONCLUSIVE

They need structure to make their arguments:

Having a Conver- sation

Clarifying

Could you give me your main idea in one sentence?

Is it your position that...

To be clear, you're saying that...

I'm confused when you say Z, Can you explain that again?

Paraphrasing

Put another way, you're saying...

So you're saying that...

Is it fair to say that you believe...

I hear you saying that...

Building On

Y mentioned that...

Yes—and furthermore...

The author's claim that Z is interesting because...

Adding to what X said,...

If we change X's position just a little, we can see that...

Agreeing

I agree with Y because...

Z's point about X was important because...

The evidence for Z is overwhelming when you consider that...

X and I are coming from the same position.

Despite disagreeing about Y, I agree with Z that...

Disagreeing

I see it differently because...

The evidence I've seen suggests something different.

Some of that is fact, but some of it is opinion as well.

I agree that Y, but we also have to consider that...

We see Z differently.

Summarizing

Overall, what I'm trying to say is...

My whole point in one sentence is...

More than anything else, I believe that...

What are you going to have them do at the end?



Formative vs. Summative



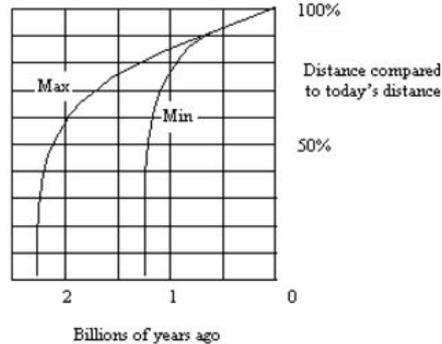
Please use the following reading passage to answer this question:

Does the new piece of data support, refute, or is inconclusive for each of the four moon formation hypotheses?

Our Escaping Moon

by: Do-While Jones

Computer Model of the Distance Between the Earth and the Moon



One of the first things NASA did when the Apollo 11 astronauts reached the Moon was to set up a laser reflector that would allow scientists on Earth to measure the distance from the Earth to the Moon. Over the 12-year period from 1969 to 1981, scientists kept track of the distance to the Moon and found it to be increasing approximately 4 cm per year. This allows us to build a computer model that calculates how close the Moon would have been to the Earth in the past. The output from that model is shown in the graph.

Use the space below to tell whether this new piece of data supports, refutes, or is inconclusive to each of the four Moon Formation hypotheses. Give specific details from the text or the graph in your answer. You do not have to fill up the whole space.

Reflections - From Students

“It’s fun, when at the end you gonna find which one is right. You be interested. Mister, c’mon, tell us which one is right. We are so interested, c’mon sir, tell us.”

“Doing on our own is much better. If he told us collision is the right one. We could ask questions and be done. Otherwise, if we annotated and ask questions, and read the data. We have more ideas about the other theories. Now, I know. Maybe somebody gonna tell me someday the Moon come from spinning around. I can tell them, I read this and it’s wrong. This is much better for me.”

- Level 2 and 3 ESL students

Reflections - From Me

- Student created rubric for arguments
- More in depth modeling
 - Representing data better in models
- Conquering NGSS and CCSS
- Less “Right Answer” discussions
-



Long ago
the Moon
was a chunk
of earth that
parted away into
space.

Earth

Asteroids

Moon

Asteroids are hitting
the Moon and Moon's
gravity keep the smashed
asteroids and not letting
them get away.

Early

①

2000-2012

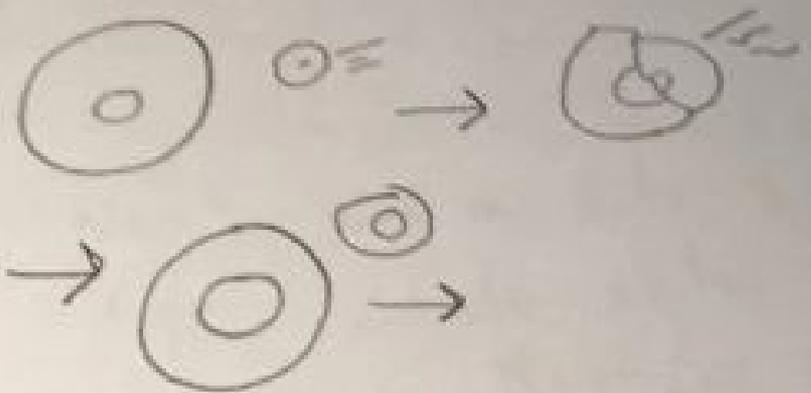
②

③

4 & 5



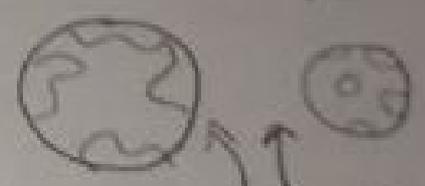
Earth



The crust & mantle formed the moon?

Earth

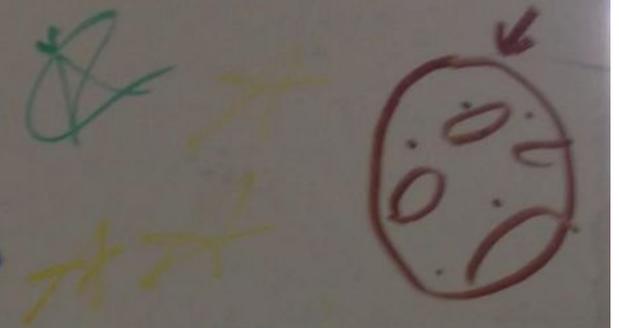
Moon



Earth & the Moon
have the same composition
of $O_{17} - O_{17}$

Earth's Early Years

Present Day



Earth

The moon was a meteoroid and it bounced back off earth and it got stuck in earth's gravitational pull to become the moon.

Earth

Length of day

Berlin



Day Length
6 hrs

Algeria



Day Length
24 hrs

Jupiter



215
Moons
/ / /
o o o

Size of Moon

Jupiter's mass - 1.898×10^{27} kg

Earth's mass - 5.97×10^{24} kg

Earth

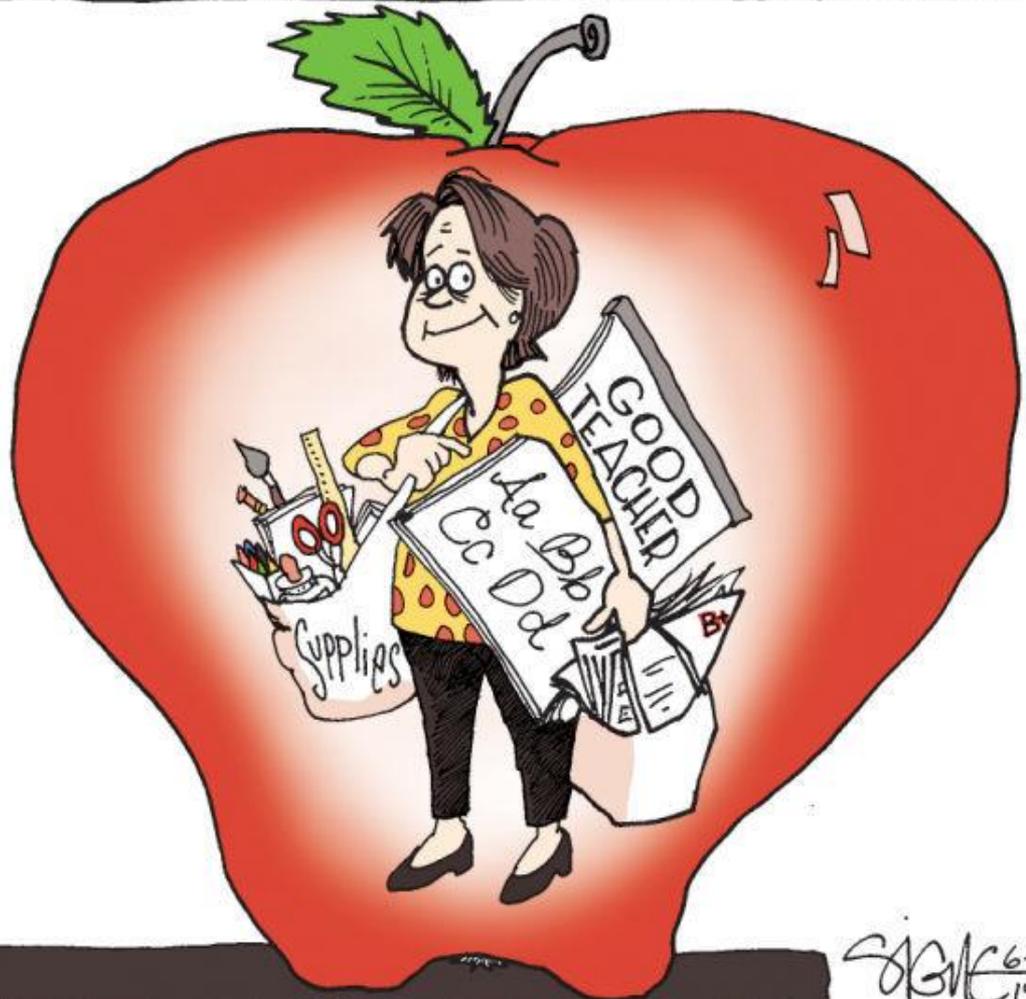


Earth's
Moon



Questions & Discussion

WHAT'S the
CORE
of the
CORE
CURRICULUM?



SJG 6.2.
14