Argumentation in the Science Classroom: Using OSS to Address the Convergence of CCSS & NGSS

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Workshop Goals

• Examine argumentation within the Next Generation Science Standards and Common Core State Standards
• Engage in some scientific argumentation activities using the Ocean Sciences Sequence
• Explore how to support argumentation effectively in your classroom
• Apply what you’ve learned to your own activities

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Thought Swap

- What are you hoping to get out of this workshop?
- What does argumentation mean to you? What does argumentation look like in a science classroom setting?
- How might engaging in argumentation help people learn science?
What do you notice?

What is argumentation?

Argumentation in science education is a process of proposing, supporting, evaluating, and refining ideas in an effort to develop a better understanding. This process of scientific argumentation occurs when a claim, often a proposed explanation, is in doubt or is contested, thereby motivating participants to defend their own ideas and challenge or question alternatives.

"Secure knowledge and understanding is as much a product of knowing why some ideas are erroneous as why other ideas are correct."

-Osborne, Erduran, and Simon, 2004
What is argumentation?

According to the NRC Framework Students with Argumentation skills will:

• Construct a scientific argument showing how the data support the claim.
• Identify possible weaknesses in scientific arguments, appropriate to the students’ level of knowledge, and discuss them using reasoning and evidence.
• Identify flaws in their own arguments and modify and improve them in response to criticism.

Argumentation in NGSS

• Asking questions
• Developing and using models
• Planning and carrying out investigations
• Analyzing and interpreting data
• Using mathematics and computational thinking
• Constructing explanations and designing solutions
• Engaging in argument from evidence
• Obtaining, evaluating, and communicating information
Three Spheres of Activity for Scientists & Engineers

Figure 3-1 from A Framework for K-12 Science Education (page 45), captioned: The three spheres of activity for scientists and engineers.

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In an NGSS environment...

• You can no longer achieve your ELA standards without a vibrant, rigorous K–12 science program.
• You cannot achieve your science standards without incorporating language and literacy.

Aside from NGSS and CCSS, why is teaching argumentation important?

• It’s what scientists do.
• It leads to improved learning outcomes.
• Helps students to be able to defend scientific views of how the natural world works.
Exploring one conceptual thread...

- 1.7: Investigating Currents
- 1.8: Making Sense of Ocean Currents
- 3.7: Investigating Climate Change: Ocean Currents
- 3.8: Connecting Climate and Ocean Currents

Guiding Question:

What is density?
For any one type of substance, such as water, it will be denser if the molecules are closer together. It will be less dense if the molecules are farther apart.

Daily Written Reflection (turn and talk)

When freshwater from a river flows into the ocean, do you think the freshwater flows to the bottom, stays near the top, or do the fresh and salt water mix together quickly? Why do you think that?
1.7 Investigating Currents

Ocean current: huge amount of water flowing in one direction over time and a long distance.

Guiding Question:
What causes ocean currents?
Session 1.8
Making Sense of Ocean Currents

Key Concept

Denser substances sink below substances that are less dense.
Guiding Question:
How is heat energy moved around Earth?
As denser water (colder and/or saltier) sinks and displaces water below it, the less dense water (warmer and/or less salty) is forced to rise to the surface. This is one way currents can form.
Currents spread heat energy throughout the ocean.

Session 1.8
Making Sense of Ocean Currents
The Great Ocean Conveyor Belt
Revised Ideas, Part 1

Imagine you are “underwater” looking sideways at the water in the ocean and could see currents moving at the poles and at the equator. Draw arrows on the diagram to show one place where water would sink, another place where it would rise, and any other water movements you want to include. Add labels to help explain why the water moves the way it does.

- Near a pole
- Ice
- Equator
- A lot of the Sun’s heat energy reaches Earth near the equator.
The water moves around in a big circle. The warm water rises, and the cold water sinks, and it just keeps going.

I think that the cold salty water at the poles sinks, and then it warms as it moves along the bottom toward the equator. But then the water at the surface near the equator moves toward the poles again because that water sank.

Questions to discuss:
1) What would you say to each of these kids? And what evidence do you have to back up your ideas?
2) Do you agree with any of the kids? If so, who? Why?
3) If you don’t completely agree with anyone, what do you think? What is your evidence?

Ocean Circulation: How do we know what we know about ocean currents?
Scientific Evidence

- Evidence is a clue that helps answer a question or explain something.
- Evidence can come from...
  - our own investigations.
  - other people’s investigations.
  - reasoning, thinking, and discussing
- Scientific explanations are based on evidence.
Turn and Talk

• What do you think might happen to ocean currents in the real ocean when ice melts and makes the water fresher on the surface?

• What might be the effect on the salinity (saltiness) of the surface water, and therefore the density?

• Based on what you saw in the model, how do you think this might affect the formation of North Atlantic Deep Water?
Three Corners

Why did the flow change when the temperature was raised in the simulation?

1) The water was less salty, so it wasn’t as dense and sank more slowly.

2) The water was less cold, so the water was less dense and sank more slowly.

3) The water was less salty and less cold, so it was less dense and sank more slowly.
Active Reading Reminders

- As you read…
  - Underline things you think are interesting or important.
  - Circle things you think are confusing, and write your questions in the margin.

- After reading…
  - Get a partner and help each other as you try to answer your questions.
Daily Written Reflection

Describe how a change in Earth’s climate might affect ocean currents.

Looking at student work

• What are you able to learn about student understanding of the science concepts?
• What do you notice about students’ use of evidence in their written responses?
Reasons for engaging in argumentation

- Deepening content understanding
- Reaching the best understanding of natural phenomena based on the available evidence
- Interpreting data
- Building data models
- Designing an investigation
- Improving reasoning skills so that you can do all of the above...
- That’s what scientists do!
The role of argumentation in SCIENCE!

• Presentation by Jude Apple

**Argumentation in NGSS**

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<tr>
<td>Engaging in Argument from Evidence</td>
<td>Engaging in argument from evidence in 6-8 builds on prior experiences and progresses to engaging in argument from evidence as a means of clarifying ideas and propositions about the natural and designed world(s).</td>
<td>Engaging in argument from evidence in 7-9 builds on evidence-based arguments and progresses to engaging in argument from evidence as a means of clarifying ideas and propositions about the natural and designed world(s).</td>
<td>Engaging in argument from evidence in 8-10 builds on evidence-based arguments and progresses to engaging in evidence-based arguments as a means of clarifying ideas and propositions about the natural and designed world(s).</td>
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<td>Compare and evaluate competing arguments or design solutions in light of current scientific evidence, new evidence, limitations (e.g., scale, scope), and societal perspectives.</td>
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What does it take to get argumentation to happen in a classroom?

- Norms established to support a culture of talk
- Science curriculum structured to support argumentation
- Questions that encourage divergent thinking
- Student understanding of what constitutes evidence and reasoning
- Classroom discussion structures that encourage debate and equal participation (e.g., science seminars, science talks, Socratic seminars)
- A teacher’s command over argumentation facilitation and questioning strategies, including strategic talk moves
- Strong command over the science content
Goals for Different Talk Moves

- Get the discussion going
- Help learners make connections
- Help learners share, expand, and clarify their own thinking
- Help learners listen carefully to one another
- Help learners deepen their reasoning
- Help learners think with others
- Help learners make explanations based on evidence
- Help learners develop scientific argumentation skills

Fish bowl checklist

You know we are using evidence to support our thinking because you hear us say things like:

__ I think __________ because __________.

You hear that we are listening to each other’s ideas because we say things like:

__ I agree with that idea because __________.
__ I disagree with that idea because __________.
__ I think I understand what you’re saying. I think you said __________.
__ Could you show me what you mean?

You see that we are listening to each other because we are:

__ Making eye contact with each other
__ Waiting to talk until the other person has finished
__ Keeping respectful expressions on our faces (no funny/mean faces)
# Argumentation Planning Template

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<th>Activity/Session name:</th>
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<tr>
<th>Key concept(s) addressed in this session (see NSES Disciplinary Core Ideas as extra resource):</th>
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<th>Question or prompt students will discuss that will lead to argumentation (should have multiple possible claims and not just be a look-up question):</th>
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<th>Goal for Argumentation: How will this discussion help students make meaning of the science content and/or build argumentation skills?</th>
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<tr>
<th>Necessary Content: What specific concepts/ideas will students need to access in order to help them respond to the argumentation question? How do you plan to help them access that information? (Readings, hands-on investigations, etc.)</th>
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## Timing: At what point in the session/activity will students answer the question and engage in argumentation?

<table>
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<th>Student Responses: How will students respond to the question? Will students generate the claims, or will you?</th>
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<th>What are some naive ideas students might have? (see relevant misconception literature if you’re not sure)</th>
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<th>Scaffolds: What scaffolds will you need to make sure all students can engage in argumentation? (concept cartoons, idea line up, four corners, norms, sentence frames, etc.)</th>
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<tbody>
<tr>
<td>Teacher will ...</td>
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<td>Students will ...</td>
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Some resources to support teachers...

- [http://inquiryproject.terc.edu/prof_dev/](http://inquiryproject.terc.edu/prof_dev/)

What kind of support will you need at your site?

- Having opportunities to talk about argumentation with your peers (PLCs)
- Having school/district/administrator/parents/school board that support you doing these things
- Having a school-wide mission to try this stuff
- Having opportunities to plan argumentation lessons
- Argumentation-infused curriculum (or, at least curriculum that lends itself to embedding opportunities for argumentation)