Science Education Partnership
Summer Session
Welcome back! Before we start...

- Sit anywhere
- Check out your security badge
- Peruse resources
- In your journal, write your goals for your experience in this program and any concerns/apprehensions
Door Prizes!
Private Eye
Welcome from Fred Hutch!
Logistics and Program Overview
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Scientific Practices Study
Break
Reflections and Discussion
1) What is **scientific argumentation**? How do you define it?

2) What is the **purpose** of scientific argumentation? Why do scientists engage in scientific argumentation?

3) Write a **brief description of some of the ways** you use argumentation in your classroom (if at all). **Tell a story** that illustrates one example.

4) What might your **students bring from their own history/culture/experiences** that would impact how they view argumentation and engage in it?

5) [If time]... What about your **own history / background** influences how you approach scientific argumentation in your classroom?
Lab Safety
DNA Lab 2
Restriction Digest
C-E-R Scaffolds
Scientific Argument

**QUESTION**
About the natural world

**CLAIM**
A proposed answer to a question about the natural world

**REASONING**
The process of making clear how your evidence supports your claim

**EVIDENCE**
Information about the natural world used to support a claim
EVIDENCE
Students use high quality evidence to support their claims.

REASONING
Students make clear how their evidence supports their claim.

CLAIM

EVIDENCE A

EVIDENCE B

EVIDENCE C
C-E-R in Conclusions

• Make a **claim** about which bands represent the **largest DNA fragments for each sample** by circling and labelling them.

• Explain why you chose those bands, **using specific quantitative (numerical) evidence** from the gel analysis chart and **reasoning** from what you know about the **properties of DNA** and the **mechanics of gel electrophoresis**.
C-E-R in Conclusions

How is the C-E-R scaffold helpful? How is it limiting?
### Creating a Scientific Argument

<table>
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<tr>
<th>Our first draft of “CLAIM – EVIDENCE – REASONING”</th>
<th>Comments from peers on improving our work</th>
<th>Our improved draft of “CLAIM – EVIDENCE – REASONING”</th>
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</table>
| **CLAIM**  Here is our claim [...we believe that X is caused by... OR we believe that Y has a role in how Z happens...]** | Is the claim clear? Is it about what is causing something to happen?  
*How do you know? Could be more specific with pressure difference (increase? decrease? inside? outside?)*  
*Take out collapse?* | **Revised CLAIM**  
We believe the steam cooling in the tanker caused the pressure in the tanker to decrease. |
| **EVIDENCE** Our evidence comes from [name the type of data and the activity it came from]. We saw in the data [name the particular trend, or outcome]. | Is the data relevant to the claim being made? If two kinds of data or observations are being compared, do they make sense to use together? Is the data credible?  
*Less than what?  
How do we know what pressure is?  
Add more evidence that is not just computer sim.* | **Revised EVIDENCE**  
Our evidence comes from the gas simulation when there was less heat, the molecules collided with the walls less than when in the presence of heat, so pressure was less due to the presence of heat. So pressure was less. We know that pressure is how molecules collide with wall from reading. |
| **REASONING** We think this evidence supports our claim because if these trends in data are happening, then it means that [state a brief causal chain of events—this chain has to be consistent with known science ideas/facts]. | Do you need to make big inferences about what happened or why? Are there big gaps in the causal story here? If you saw this kind of data, does it mean that their claim can be the ONLY one that is true? Should they moderate their claim?  
*Did the pressure outside increase?* | **Improved REASONING**  
When the steam inside cooled, the gas molecules collided with the walls less, which means pressure inside tanker decreased. |
Semi-Log Plotting
Closure

- Summary
- Looking ahead
- Feedback
- Flow chart required for Transformation Lab
On-line Resources for Lab Journals & Notebooks

- Maintaining a laboratory notebook by Colin Purrington
  This one even suggests what types of pen to use since many inks bleed if a solvent spills on your notebook pages.
  more...

- STEM Notebooks from LASER
  www.science(notebooks.org
  Science notebooks can be used to help students develop, practice, and refine their science understanding, while also enhancing reading, writing, mathematics and communications. On this site you will find examples of student work from science notebooks - many from common used commercially developed science instructional materials, information to support the use of science notebooks, and more.

Journal Exemplars

- ToC Example 1
- ToC Example 2
- ToC Example 3
- ToC Example 4
- CPR2 example 1
- CPR2 example 2
- CPR² example 3 - Divergent
- Flow Chart Example 1
- Flow Chart Example 2
- Flowchart Example 3
- Flowchart Example 4
- Flowchart Example 5
DNA Extraction (Strawberry)

Concepts: The scientific concepts we were working with in this lab were involving composition of DNA in the cell and how to work with those properties to extract the DNA.

Processes: The strawberry was first mashed inside a plastic baggie to break up the cell wall and cell membrane. The "extraction buffer" was added. The buffer was made up of soap (in order to dissolve lipids of cell membrane), meat tenderizer (in order to break up proteins), salt (in order to neutralize the DNA's (-) charge) + water. It was mashed some more, then filtered. Cold ethanol was added, which caused the DNA to precipitate out of the solution. The DNA was wound around a stick and put into a tube.

Results: The results were qualitative. We extracted about 1 1/2 tubes worth of DNA, which is the consistency of snot.

Reflections & Attitudes: I have done this lab in the classroom many times and I enjoy the hands-on nature of the lab. I have looked for ways to tweak it and make it more qualitative or inquiry-based. I like the idea for the next time of trying it in the classroom for students to try and experimentally determine the composition of the extraction buffer, given a different source of the DNA (i.e. cheek cells, other fruit). In order to make this happen, students would need to know what each ingredient does in the extraction buffer.
ICE

42°C, 90 sec

ICE

250 µL sterile LB to

1000-1500 µL

Tap to mix

15-30 min 37°C

CLEAN/Organize

DIREC TED

Label Plates

LB

LB/amp/β-gal

LB/amp/x-gal

100 µL out to each plate

n.e.t.

5 min → 37°C incubation

5 min → 37°C incubation

BOTTOMS UP!!!

CLEAN up!!!
Teaching the DNA labs
Argumentation as a Scientific Practice
Science and Engineering Practices

- Asking questions (for science) and defining problems (for engineering)
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations (for science) and designing solutions (for engineering)
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

NRC, Frameworks for K-12 Science Education, p. 42
Central Role of Argument

NRC Framework for K-12 Science Education, 2012, p. 45
The notion that there is a single scientific method of observation, hypothesis, deduction, and conclusion – a myth perpetuated to this day by many textbooks – is fundamentally wrong... the picture of scientific reasoning is richer, more complex, and more diverse than the image of a linear and unitary scientific method would suggest.

What engages all scientists, however, is a process of critique and argumentation. Because they examine each other’s ideas and look for flaws, controversy and debate among scientists are normal occurrences, neither exceptional nor extraordinary.

NRC Framework for K-12 Science Education, 2012, p. 78
Argumentation Elements

EVIDENCE
Students use high quality evidence to support their claims.

REASONING
Students make clear how their evidence supports their claim.

INTERACTIVE
Students build off of and critique each others’ ideas.

COMPETING CLAIMS
Students critique competing claims.
INTERACTIVE
Students build off of and critique each others’ ideas.

COMPETING CLAIMS
Students critique competing claims.
Norms and Accountable Talk

• Accountability to Accurate Knowledge

• Accountability to Rigorous Thinking

• Accountability to the Learning Community (Equity, Respect)
Questions for Sense-making

• Asking for evidence or reasoning behind a claim (including evaluating evidence quality)

• Asking a probing question

• Asking for clarification

• Adding on to an idea

• Respectfully disagreeing with an idea
Ask a Probing Question

What made you think that?

If that true wouldn’t … be true

How did you test that?

How did you come to this conclusion?

But is there a downside to what you said?

Why do you think that?

Why do you think it’s important?

Where did you get that from?

Why do you think that is important?

Why did you think that? ……

Example prompts from the other three posters in this classroom set:

Adding to an idea:
  • I agree with you but I also think…
  • I agree with you but couldn’t you add…?
  • I agree with you because…

Respectfully disagreeing with an idea:
  • I know where you’re coming from, but I have a different idea.
  • I disagree with the idea because…
  • I think you’re headig in the right direction, but…

Asking a clarifying idea:
  • What do you mean by…?
  • What makes you think that?
  • Could you be more specific?

Figure X. Student-created scaffolds for how to address peers’ ideas
Idea Coaching

- Pair up and designate the starting “coach”
- Question for discussion: **What did this lab teach us about DNA and restriction enzymes?**
- Think about what you want to say for a few minutes before we begin.
- Coaches can use questions that we’ve generated as resources (as appropriate).
- Resist the urge to talk about your own ideas when you are listening and coaching! You want to help your partner “move their ideas forward”!
- Set a timer so you know when to switch roles.
Other Scaffolded Pair Discussions

- Listen and revoice
- Build on or challenge an idea
- Identify similarities and differences

Windschitl, Discourse [private communication]
Transformation
Scale: Dilutions and Solutions
Models
Water and Insulin
Bloodborne Pathogen Training
Your Own Experiment
Looking Ahead
Welcome Back!

• Pair up with someone you haven’t met or worked with yet

• Check your “mailbox”
Models in the Classroom
INTERACTIVE
Students build off of and critique each others’ ideas.

COMPETING CLAIMS
Students critique competing claims.
Lab Meeting Video
Lab Meeting Video

- What was the purpose of this discussion?
- What kinds of evidence did people bring into the conversation?
- Did you hear claims or justifications/reasoning?
- Were people trying to suggest competing claims or critique each other’s ideas?
- How important is critique? How important is it to be able to give and get feedback in a non-adversarial way?
Argumentation as a Practice
In the **evidence gradient tool** students rank evidence cards according to particular criterion for evidence quality. Subsequently, students rank evidence cards by how well they support a given claim.

When **gathering evidence** students can engage with hands-on, simulations, text or diagrams to identify and record evidence in relation to a claim.

In the **reasoning tool** students fill in three columns for evidence, reasoning and claim. The central reasoning column is filled in last as the link between evidence and claim.

In a **science seminar** students participate in a whole class, student-led discussion, with a day before for exploring evidence and claims, and a day after for argument writing.

In the first use of the **anticipation guide** students respond to several claims containing common misconceptions. Later, students revise their responses and eventually rewrite the claims.

In an **evidence card sort** students sort evidence cards according to which or several competing claims the evidence best supports.

In **oral argumentation** students engage in interactive discourse where they both build on each other’s ideas and critique peer’s arguments.

In **argument writing** students provide a claim that is supported by high quality evidence with clear reasoning connecting the claim and evidence.
Resources

- Argumentation Tool Kit ([Student Video](#))
- StemTeachingTools
- Ambitious Science Teaching
- TalkScience Primer
- Accountable Talk
Observations and Reflections in the Lab
Transformation Lab Results
Science Seminar
Shared inquiry, not debate

The goal is to achieve an enlarged understanding of the results.
• Circle (Inner, Outer, Hot seat)
• Norms
• Discussion Resource (Text, Data)
• Wait Time
• Assessment
• Questions
Types of Questions for Seminar

- For understanding factual information
- For generating claims with justifications from data
- For personal perspective
- For moving the conversation along or broadening participation
- For summarizing/integrating
Types of Questions for Seminar

- For understanding factual information
- For generating claims with justifications from data
- For personal perspective
- For moving the conversation along or broadening participation
- For summarizing/integrating
Our starting questions

- **DATA** - How do your results compare to your predictions?

  **Claim:** What might account for any differences?

- **Evidence:** What evidence do you have to support your assertions? Or, how could you test your assertions?

- **SUMMARIZING**

  **Claim:** What do you think is the most important thing to understand about transformation?
Do your own experiment
Audience Roles

- Questions about Predictions
- Questions about Theories
- Questions about Results
- Questions connecting Theories, Predictions, and Findings

[Herrenkohl and Guerra, 1998]
Audience Questions for Sense-making

- Asking for evidence or reasoning behind a claim (including evaluating evidence quality)
- Asking a probing question
- Asking for clarification
Lab Days

- Journaling CPR2 and Argumentation Reflections
  - Don’t forget an **Argumentation Example**

- Visits from Lead Teachers and Caren

- Understanding by Design Powerpoint on SEPGuides

- Lee Hartwell Discussion (Thursday 3pm)

- Meet with Lead Teacher before going
THANK YOU