Teaching and Learning with the Science and Engineering Practices: Models, Explanations and Argumentation

Kate McNeill and María González-Howard
Boston College
Pam Pelletier
Boston Public Schools

Agenda

- Overview
- Discussion – NSTA@NGSS resources
- Activity 1: Discuss Posters from Last Session
- Presentation on Modeling, Explanation and Argumentation
- Activity 2: Sinking and Floating Investigation – Focus on 3 practices
- Activity 3: Revise definitions and/or image of 3 practices
- Homework – Can Do/ Did I? Feedback

PowerPoint at: http://www.katherinelmcneill.com

Goals for 5 Meetings

- Develop a deeper understanding of the 8 science practices in NGSS
  - Clarifying definitions of each practice
  - Explore the relationships between the 8 practices
- Develop strategies to adapt existing curriculum to align more closely with the science practices
  - Identify challenges around adapting (both student challenges and lesson design challenges)
  - Develop strategies for designing lessons

Activity #1 - Discussion of Resources on NGSS@NSTA

- With your group, discuss the resources you examined from the website. Some questions to consider:
  - How well do you think the resources would engage and support students in the science practices? Why?
  - Do they discuss an student challenges or strategies that we should add to our lists?
  - How would you recommend that these resources be presented and used by teachers?

Activity #2: Posters from Last Session. Similarities and Differences between Practices 4 and 5

- On a large chart paper with your group create a representation that illustrates:
  - How are *Analyzing and Interpreting Data* and *Mathematical and Computational Thinking* similar and different from each other?
  - What are the key similarities?
  - What are the key differences?
- Resources
  - 3 Handouts - Appendix F. BSCS definitions, Science Practices Leadership definitions

Activity #2: Similarities and Differences between Practices 4 and 5

- Discuss with your group your poster from last meeting – refresh memory (5 min)
- Groups each share their poster
- Discussion across the posters
  - What similarities do we see across the posters?
  - What differences do we see across the posters?
  - What suggestions and/or questions do we still have?

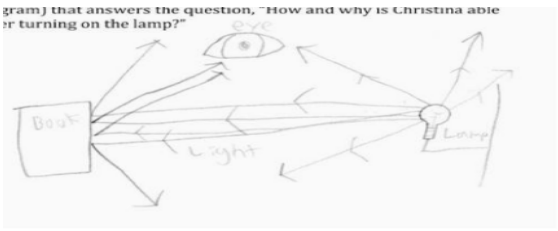
Defining Models, Explanations & Arguments

- Developing and using models
  - A model is an abstract representation of phenomena that is a tool used to predict or explain the world. Models can be represented as diagrams, 3-D objects, mathematical representations, analogies, or computer simulations.
- Constructing explanations
  - A scientific explanation is an explanatory account that articulates how or why a natural phenomenon occurs that is supported by evidence and scientific ideas (potentially from a model).
- Engaging in argument from evidence
  - Scientific argumentation is a process that occurs when there are multiple ideas or claims (e.g. explanations, models) to discuss and reconcile. An argument includes a claim supported by evidence and reasoning as well as evaluates and critiques competing claims.

Defining the 3 Practices in NGSS

- Developing and using models
  - A model is an abstract representation of phenomena that is a tool used to predict or explain the world. Models can be represented as diagrams, 3-D objects, mathematical representations, analogies, or computer simulations.
- Constructing explanations
  - A scientific explanation is an explanatory account that articulates how or why a natural phenomenon occurs that is supported by evidence and scientific ideas (potentially from a model).
- Engaging in argument from evidence
  - Scientific argumentation is a process that occurs when there are multiple ideas or claims (e.g. explanations, models) to discuss and reconcile. An argument includes a claim supported by evidence and reasoning as well as evaluates and critiques competing claims.

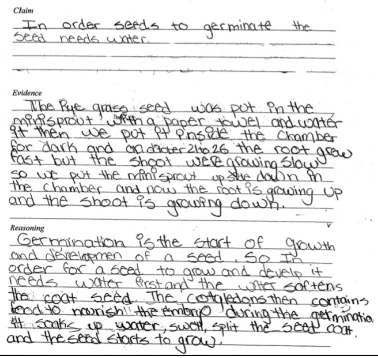
Model – How does light travel



Defining the 3 Practices in NGSS

- Developing and using models
  - A model is an abstract representation of phenomena that is a tool used to predict or explain the world. Models can be represented as diagrams, 3-D objects, mathematical representations, analogies, or computer simulations.
- Constructing explanations
  - A scientific explanation is an explanatory account that articulates how or why a natural phenomenon occurs that is supported by evidence and scientific ideas (potentially from a model).
- Engaging in argument from evidence
  - Scientific argumentation is a process that occurs when there are multiple ideas or claims (e.g. explanations, models) to discuss and reconcile. An argument includes a claim supported by evidence and reasoning as well as evaluates and critiques competing claims.

Explanation – What causes seeds to germinate?


Claim

In order seeds to germinate the seed needs water.

Evidence

The Pye grass seed was put in the mini sprout with a paper towel and water it then we put it inside the chamber for dark and on day 2 to 26 the root grew fast but the shoot was growing slow so we put the mini sprout upside down in the chamber and now the root is growing up and the shoot is growing down.

Reasoning

Germination is the start of growth and development of a seed. So in order for a seed to grow and develop it needs water first and the water softens the coat seed. The cotyledons then contains food to nourish the embryo during the germinatio it soaks up water, swell, split the seed coat and the seed starts to grow.

Defining the 3 Practices in NGSS

- Developing and using models
  - A model is an abstract representation of phenomena that is a tool used to predict or explain the world. Models can be represented as diagrams, 3-D objects, mathematical representations, analogies, or computer simulations.
- Constructing explanations
  - A scientific explanation is an explanatory account that articulates how or why a natural phenomenon occurs that is supported by evidence and scientific ideas (potentially from a model).
- Engaging in argument from evidence
  - Scientific argumentation is a process that occurs when there are multiple ideas or claims (e.g. explanations, models) to discuss and reconcile. An argument includes a claim supported by evidence and reasoning as well as evaluates and critiques competing claims.

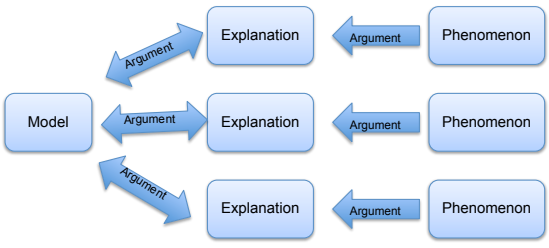
Argument - What affects the water quality in our stream?

"My partner though that the reason the levels might be so bad is that there might be left over salt from last year. Well I don't have any solid evidence to contradict this theory, I do have critical thinking on my side. We were told that in pervious years of testing the results were much, much worse because it had already snowed and salt had already been put down on the parking lots. Since this year the levels were down so much *because* of the lack of salt, that makes me believe that any salt that may be left over isn't sufficient to affect it hat much, because if the salt really was affecting it drastically we would probably be getting closer results to what other testers have gotten in previous years."

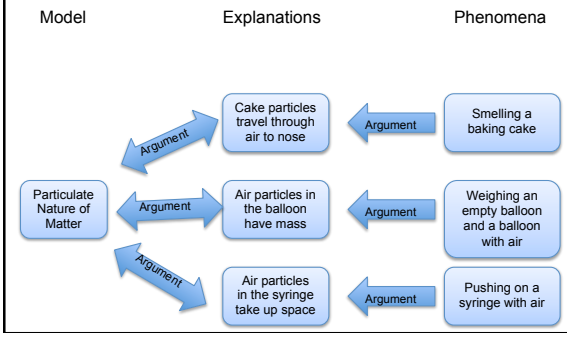
Distinction between the 3 practices is challenging

- The distinction between an explanation, argument and a model can be challenging at times.
- The practices often occur at the same time during classroom instruction
  - Students construct an explanation using a model
  - Students engage in argument about 3 competing models
  - Students engage in argument about how to use 1 model to construct an explanation about a phenomenon

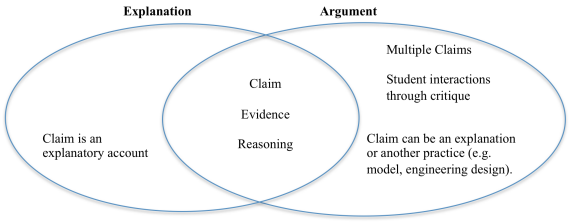
Relationship between explanations, models and argumentation



Relationship between explanations, models and argumentation



Relationship between Explanation and Argument in NGSS



Activity 3: Sinking & Floating

Why do some objects sink and other objects float?

With Your Group:

1. Discuss why you think some objects sink and other objects float – Write prediction on page 1
2. Look at bag of objects. Pick 10 objects you want to test
3. Write your prediction for each object in the table on page 2
4. Investigate which objects sink and float. Record your observations in the table on page 2
5. Answer conclusion question on page 3

Activity 3: Sinking & Floating

Discussion

- Based on your experiment – What are some factors that influence whether an object sinks or floats?
- We will list potential factors on a large piece of paper – we do not need to agree at this point.

Activity 3: Sinking & Floating

Why do some objects sink and other objects float?

With your Group:

- Create a model on a large piece of sticky paper explaining what is happening inside the water to make things sink or float

Everyone

- Post models at the front of the room
- What do you think is the strongest model to explain sinking and floating? Is it one of these? Or a combination of them? Why? What is your evidence?

Activity #3 – When did we engage in these 3 practices?

- Developing and using models
  - A model is an abstract representation of phenomena that is a tool used to predict or explain the world. Models can be represented as diagrams, 3-D objects, mathematical representations, analogies, or computer simulations.
- Constructing explanations
  - A scientific explanation is an explanatory account that articulates how or why a natural phenomenon occurs that is supported by evidence and scientific ideas (potentially from a model).
- Engaging in argument from evidence
  - Scientific argumentation is a process that occurs when there are multiple ideas or claims (e.g. explanations, models) to discuss and reconcile. An argument includes a claim supported by evidence and reasoning as well as evaluates and critiques competing claims.

Activity #4: Explanation, Argument & Modeling

- On a large chart paper with your group:

1. Revise the definitions of explanation, argument and models

   AND/OR

2. Create a new image for explanation, argument and models

Next Time: "Can Do" and "Did I" Statements

- Before our next meeting on May 27, we would like you to provide feedback on the BPS "Can Do and "Did I" statements. You could –
  - Share with colleagues
  - Use them to plan a lesson
  - Try using them with your students
  - Other?

Contact Information

- Kate's e-mail – kmcneill@bc.edu
- Maria's e-mail – gonzaldx@bc.edu
- Pam's e-mail - ppelletier@bostonpublicschools.org

http://www.katherinelmcneill.com

- Workshops
  - Has the powerpoint