The Nature of Science

Middle School SCIEnCE
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Welcome!

- Introductions
- What are we doing today?
- What can I expect to leave today with?

Day 2: Morning schedule

- Inquiry-based learning, the Scientific Method
- NOS Icebreaker
- Break
- 6 tenets of the NOS
- The Learning Cycle
- Teaching the NOS in context: looking at the new SOLs
- Lunch

Inquiry-based Learning (IBL)

- Efforts to coordinate hypothesis, observation and evidence through the study of controlled, cause and effect relationships (Kuhn, 2005)
- **4 levels of inquiry** (Banchi & Bell, 2008)
  - confirmation inquiry (question, procedure, outcome provided)
  - structured inquiry (question, procedure provided)
  - guided inquiry (question provided)
  - open inquiry (all student-generated)
- The key to IBL: **DATA!**

The scientific method

- What is it, and how do you teach it?
- Activity

The question

- ***How do inquiry-based learning, IBL, and the "scientific method(s)" support the NOS?***

Icebreaker

- Making observations

Process skills and the 6 tenets of NOS (Bell, 2007)

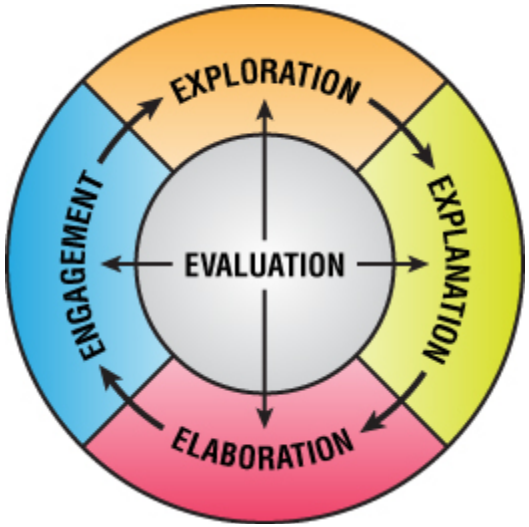
Process Skill	NOS tenet
Observing	Scientific conclusions are based on evidence. They can change as new evidence becomes available
Inferencing	Scientific conclusions involve observation and inference (not just observations alone)
Classifying	There is often no single "right" answer in science

Process skills and the 6 tenets of NOS (cont'd)

Process skill	NOS tenet
Designing experiments	There are many ways to do good science. There is no single method that all scientists follow.
Predicting/hypothesizing	Scientific theories provide the foundation on which predictions and hypotheses are built.
Concluding	Scientific conclusions can be influenced by scientists' background knowledge. Theories provide frameworks for data interpretation.

The Learning Cycle (5 Es)

- State objectives, context, necessary preparations, and time allotments for activities
- Instruction to address each of the following phase



Engage phase

- Initiates learning
- Introduces major ideas
- Connects past and present learning (activation)
- Student thinking in upcoming inquiry
- Mental engagement
- Motivates students

Explore phase

- Provides opportunities for learners to test their ideas against new experiences
- Provide opportunities for students to compare ideas with each other
- Provide common experience (context) to actively explore environment

Explain phase

- Provides opportunities for learners to develop explanations of their own (can be collective)
- Introduces new terminology and content information to ***ease communication***

Elaborate phase

- Applies/extends learning to new contexts
- Provides opportunities for learners to develop deeper understanding

Evaluate phase

- Encourages students to assess their own understanding in order to solve new problems (metacognition)
- Gets you the feedback you need to understand what students know

A full lesson plan using a 5Es approach

- Is inquiry-based, providing multiple representations of ideas to students at each phase
- Because it is inquiry-based, the objectives must be *very clear* from the beginning, and a realistic time budget is *critical*
  - Criticisms of inquiry-based approaches
- Assessments must be level-appropriate, and tell you the information you want to know
  - Are you assigning a grade based on your assessment?

NOS in context (groups of 3-4)

- In small groups look over the new SOLs on NOS and discuss them
- Starter prompts
  - What challenges have you encountered over the past year in incorporating NOS into your science lessons? Successes?
  - Which do you think are the hardest to incorporate into your existing lesson plans?
  - Which of these ideas are you already very comfortable with?
  - What are some strategies you can develop to teach NOS in context rather than in isolation?

Day 2: Afternoon schedule

- NOS in context: the nature of matter as a an example
- Lots of activities to try and take to your classroom!
  - "Mystery shapes"
  - Modeling of the atom
  - Calorimetry lab
- Workshop using your labs
- Share time and wrap up
- Adjourn

How do we know about the properties of atoms?

- Making observations, inferences, and drawing conclusions on models of atoms
- Interpreting data: science is ***tentative***

Two models of particle physics

- Clay atoms (think-pair-share)
  - Which tool was most useful to you?
  - Did your neighbor choose the same one?
  - Did you ultimately draw the correct conclusion?
  - If not, what other information would have helped?
- "Mystery shapes" game (groups of 2-3)
  - http://www.teacherlink.org/mysteryshapes

The “right” answers

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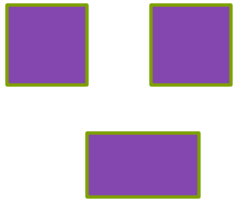
2



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Designing labs that highlight the NOS

- In pairs, work on completing the Calorimetry Lab
- As you do so, think about the ways in which IBL, the Scientific Method, and The Learning Cycle come into play
- Also be sure to jot down any critiques of or adaptations to the lab that would help you implement this with your middle schoolers

Working with your labs

- You each brought a lab with you
- In groups of 3-4, share your labs with one another
  - Discuss any issues you have had implementing the lab– what has worked well, what could be better, etc.
  - Focus on the tenets of the NOS we have been discussing
  - What changes can you make to the lab to make NOS SOLs explicit?
- Share highlights of your discussions with the whole group