Prompts to Initiate Student Science Performances

William R. Penuel
University of Colorado Boulder

How do you elicit and make use of student questions in your class now?

How do you elicit and make use of student questions in your class now?

"Children everywhere are schooled to become masters at answering questions and to remain novices at asking them."

J. T. Dillon

Asking Questions in the Utah Core Standards

+ **Ask questions** to predict how changes in resource availability affects organisms in those ecosystems. (6.4.1)
+ **Ask questions** to identify constraints of specific geologic hazards and evaluate competing design solutions for maintaining the stability of human-engineered structures, such as homes, roads, and bridges. (7.2.3)
+ **Ask questions** and analyze and interpret data about the patterns between plate tectonics and (1) the occurrence of earthquakes and volcanoes; (2) continental and ocean floor features; (3) The distribution of rocks and fossils. (7.2.5)

Asking Questions in the Utah Core Standards

+ **Ask questions** about how the amount of potential energy varies as distance within the system changes. (8.2.2)
+ **Ask questions** to obtain, evaluate, and communicate information about how changes to an ecosystem affect the stability of cycling matter and the flow of energy among living and nonliving parts of an ecosystem. (8.3.3)

What questions do we need to answer?

Design Challenge: You class can choose a tree to plant in your schoolyard. You need to choose a tree to plant that will:

- Maximize biodiversity of the tree canopy in the community
- Provide habitat to multiple species of organisms
- Maximize ecosystem services for human beings in the community

What questions do we need to answer?

- **Group A:** Maximize biodiversity of the tree canopy in the community
- **Group B:** Provide habitat to multiple species of organisms
- **Group C:** Maximize ecosystem services for human beings in the community

As part of your group discussion, look for **evidence** from information you can obtain related to your question that justifies why you need to answer the question.

What questions do we need to answer?

- **Group A:** Maximize biodiversity of the tree canopy in the community
- **Group B:** Provide habitat to multiple species of organisms
- **Group C:** Maximize ecosystem services for human beings in the community

Now form a group with a member from group A, B, and C:
1. Discuss the questions you generated.
2. Prioritize questions you think you need to answer to solve the design question.
3. Write down and prepare to defend your priorities with **evidence** you have obtained.

Why all the fuss about questions?

Asking questions is essential to developing scientific habits of mind. Even for individuals who do not become scientists or engineers, the ability to ask well-defined questions is an important component of science literacy, helping to make them critical consumers of scientific knowledge.
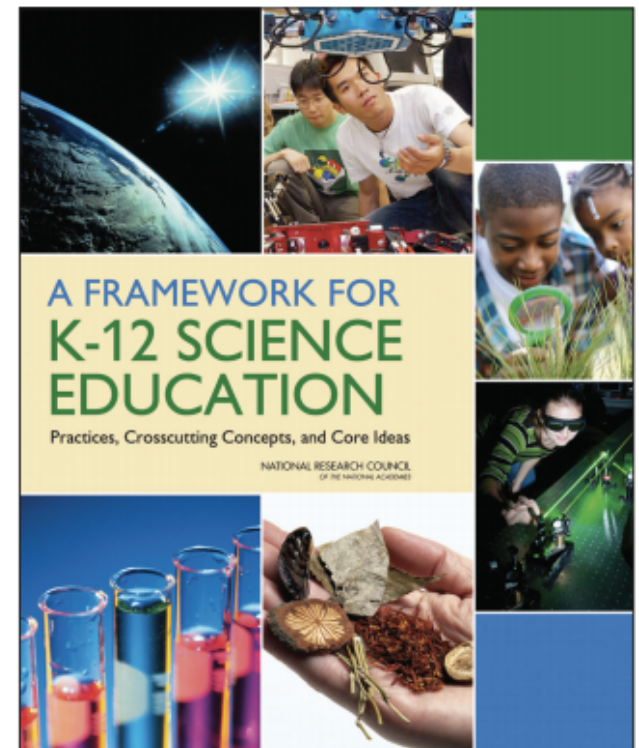
Working with Students to Refine Questions

+ Ask students about **specific aspects** of the phenomenon or design challenge.
    + *Work in groups A, B, and C helped the group to see the complexity of the design challenge.*
+ Ask students to **select** questions they can investigate.
    + *Selecting questions requires students to prioritize, and asking them to defend their choices helps make explicit their initial understandings of the phenomenon or challenge.*
+ Introduce **new dimensions** of the problem or situation to consider after an initial brainstorm.

Some Talk Moves for Refining Questions

+ Is there a way we could phrase our question, so that we can investigate it in class?
+ How could you investigate that question?
+ In your question, what are the independent and dependent variables?
+ If that's your investigation, what question can that answer?
+ What new questions do you have, after today's investigation?
+ What questions could you ask to identify the assumptions of this model?

But wait, there's more....

Engineering asks:
+ What is the need or desire that underlies the problem?
+ What are the criteria (specifications) for a successful solution?
+ What are the constraints?
+ Will this solution meet the design criteria?
+ Can two or more ideas be combined to produce a better solution?

ACTIVITY: Which Questions....

+ Relate to the human needs or desires that must be satisfied?
+ Relate to constraints you will need to understand better?
+ Imply or indicate directly trade-offs between desired components of the solutions?
  + *What are some of the trade-offs you anticipate having to make?*

Our Ecosystems Design Challenge

+ Addresses disciplinary core ideas related to ecosystems
+ Engages students in the full range of science and engineering practices
+ Requires students to make connections to crosscutting concepts

Our Ecosystems Design Challenge

+ Addresses disciplinary core ideas related to ecosystems
+ Engages students in the full range of science and engineering practices
+ Requires students to make connections to crosscutting concepts

Utah Core Science Standard 6.4.5
Evaluate competing design solutions for preserving ecosystem services that protect resources and biodiversity based on how well the solutions maintain stability within the ecosystem. Emphasize obtaining, evaluating, and communicating information of differing design solutions.

How We Work with Students to Refine Questions: Storyline

Driving Question/ Phenomenon	Engage in a Practice	Connect to Student Interests	What Students Figure Out	New Questions

http://tinyurl.com/StorylineTemplate

How We Introduce Complexity...

Clarifying Constraints

How We Introduce Complexity...

Asking Students to Construct Arguments
Use evidence from what you have learned about ecosystems to justify your choice of tree.

Develop claims, evidence, and reasoning to answer:
- Which tree will provide the most shade to cool the air soonest?
- Which will require the fewest resources to keep alive?
- Which will provide the most habitat?

Connections to Literacy

+ Constructing arguments from evidence
+ Oral presentation and discussion skills

These slides and materials for today's session are available at

http://learndbir.org

Design Based
Implementation
Research