PlantingScience Mentor Tip Sheet: Wonder of Seeds Curricular Module

The **purpose of this tip sheet** is to help you as a scientist mentor **anticipate and respond** to students as they post online about their germination and seedling growth investigations.

Expect teachers to adapt module for their students:

PlantingScience provides a selection of monocot and eudicot seeds. Teachers provide materials for growth chambers and additional seeds if desired. The equipment available and class experience with inquiry learning will influence the direction investigations take.

- Connect with your teams' teacher via the **Teacher-and-Mentor Forum** for details.
- Please see the **Module Guide** for learning goals, suggested activities, and schedule planner.
- See **Mentor Guide** for hints talking with students.

The Wonder of Seeds module is widely accessible to diverse learners and the most popular module. Teachers, instead of directing students to a particular question, often use it as **an open inquiry**. It may be one of the students' first experiences generating their own research questions. We provide a **variety of seeds** to allow students to observe closely and consider how differences between species and among individuals might play a role in germination and growth. We suggest a number of ways student might create **growth chambers** and investigation **tools** such as microscopes, digital cameras, light systems, etc. We encourage students to collect both quantitative and qualitative data on seeds and seedlings across a 2-week period. Depending on the seed source, the student questions, and the class schedule, data collection may last 1-4+weeks. Big ideas in this module link closely to respiration and photosynthesis. This module also works well with an introductory Corn Competition to illustrate the value of a control.

Juicy questions for student investigations.

- Does growth always mean gaining weight?
- Is a seed alive?
- Do seeds need soil to germinate?
- Can you drown a seed? How fast do seeds absorb water?
- How is food made? How is it stored?
- What does it mean to grow? What are good measures of growth?
- What do weight measurements reveal about plant growth?

What are students thinking when it comes to germination and growth?

As students blog about their investigations, they reveal their ideas. It is common for students to believe…

- plants get food from soil; plant mass comes from the soil.
- sunlight, carbon dioxide, water, and minerals are food.
- sunlight is helpful but not essential to plant growth.
- roots are feeding organs.
- all plants have seeds.
- all plants have either one or two cotyledons.

View the video, ***Lessons from Thin Air***, Hear how Harvard students and a fifth grader answer the question,
"Where does the mass of an oak tree come from, if it starts out as an acorn?"
(program 2; free registration required)

Attending to students' ideas and thinking

By attending to students' thinking, attention shifts from a right-answer orientation to uncovering student ideas and reasoning. As experts, we often make assumptions about what a student is meaning and connect concepts in ways novice learners cannot. Assumptions are often turned on their heads when probed. Also, responding as a naïve mind opens up possibilities in the discussion. Although students often learn by rote that seeds contain the plant embryo and stored food, that seed germination and vegetative growth depend on many of the same environmental conditions (presence of water and oxygen, temperature in a certain range) is often a "missed" concept. **What is a plant's environment? What is happening during germination, during vegetative growth?** This process of armchair inquiry, or **digging into juicy questions**, is a highly valued process in science.

Anticipating technical problems and conversation threads

Helping students realize that experiments don't always work first time for scientists is important, as **problem solving** and trouble-shooting are highly valued in science and other work places. However, don't let the students get overly bogged down in technical debugging at the expense of also thinking about the big ideas. Due in part to an increasing disconnect with nature in the U.S. population, many students struggle with rooting germination and growth questions in biologically meaningful contexts.

- **Seeds prone to mold.**
  This is often a problem for seeds germinated in plastic baggies &/or in the dark; less likely for surface-sterilized seeds in open-air containers placed in the light. Baggies may be the growth chamber of choice given their classroom convenience. Fungal growth is expected if experiments include sugar—a teachable moment. Difficulty distinguishing fungus from root hairs presents an opportunity for students to observe how the "fuzzy filaments" are aligned and where they occur.
- **Shifting from anthropocentric to plant perspectives, meeting students where they are.**
  Plant responses to soda or music are often students' first thoughts (not encouraged by the module!). Students may resist changing questions, despite encouragement to consider variables from nature. It is valuable, then, to help students see the environment from a plant's perspective, recognize multiple variables, and think about how to turn this into a scientifically sound test.
- **Making sense of unexpected results.**
  If students explore how fresh and dry weight changes from the time seeds germinate until the first true leaves appear, they will likely be surprised that dry weight decreases during germination and increases once greening begins.
- **Making sense of light, temperature, plant environments and adaptations.**
  Everyday experiences allow students to recognize shade and sun-loving plants, summer and winter crops. Students enjoy testing different light wavelengths on plants. They find it hard to connect environmental and genetic influences on these processes and to consider patterns of adaptation.

Resources

Teachers say it is hard to find accessible, scientific accurate background information for students. Are there resources you recommend?

Perhaps useful to you as a mentor

Plant Physiology online
http://4e.plantphys.net/

Responding to the Rainbow — Experiments with LED light systems
http://www.respondingtotherainbow.com/

Barman, C.R. et al. 2006. Students' ideas about plants and plant growth. *American Biology Teacher* 68(2): 73-79.

Perhaps useful to student teams

Time-lapse movies of germination
http://plantsinmotion.bio.indiana.edu/plantmotion/earlygrowth/germination/germ.html

EurekaAlert! For Kids — Kid-friendly science news releases
http://www.eurekalert.org/kidsnews/

Seed technologists test seed lot performance under stress
http://www.harrismoran.com/technology/newsletters/2.htm