HOW THE SCIENTISTS REALLY WORK

Performance Standard 13A/12A-F/13B.J

Students will question the accepted practices of science by scientists and their interactions with technology and society accordingly:

- *Knowledge*: Define the applicable scientific habits of mind and conditions for work facing scientists as they do their research.
- *Application*: Devise and conduct appropriate interview procedures for scientists to question their understanding and application of scientific habits of mind and conditions for research work.
- *Communication*: Present findings of interviews with scientists to correlate, confirm, contrast and generalize the common and unique habits of mind necessary in the work of scientists.

Procedures

1. ***In order to know and apply accepted practices of science (13A), understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences (12 A-F) and the concepts that describe the interaction between science, technology and society (13B),*** students should experience sufficient learning opportunities to develop the following:
   - Generate a listing of the accepted practices, processes and scientific habits of mind that scientists in all fields must address.
   - Prepare for interviewing scientists in contextual fields of science (from curricular units):
     - Determine strategy for access to scientists.
     - Determine common questions for all interviews.
   - Conduct interviews, recording all responses and tangential conversation topics.
   - Determine conclusions of comparative and contrasting scientific habits of mind of scientists.

   Note to teacher: This activity integrates information as suggested in standard 13A at stage J. In should incorporate information from scientists associated with in timely curricular units from standards 12 A-F at stage J. This activity is an extension from a suggested activity/assessment from 13A at the G stage. It can be repeated at this stage with greater sophistication and more detailed questioning foundations.
2. Have students review and discuss the assessment task and how the rubric will be used to evaluate their work.
3. Introduce activity by having students brainstorm ideas about how a scientist thinks. The purpose is to set the stage for the kinds of scientific thinking that are the classroom rules for the year. All ideas should be recorded. Ask students to distinguish and delete ideas which characterize what a scientist does. Use this initial listing to research scientific habits of mind, the nature of science and the accepted practices of science. Divide students into small groups to create working definitions for 1-2 "habits". If research is found to add more "habits" than were originally suggested from class brainstorming activity, students can present their additional suggestions for class "adoption". Each group will present its definition of its assigned habit(s). The class must work to refine and adopt the final definition to be used for class thinking and for the next activity.
4. Students should develop a set of 5-8 questions that will be used by all students in a series of interviews of adults. The questions may focus on some of the following considerations that are common to the work of scientists:
   - How they realize scientific habits of mind (scientific reasoning, insight, creativity, skill, intellectual honesty, tolerance of ambiguity, skepticism, persistence, openness to new ideas and sheer luck, etc.) in their work. (How the habits of mind are important in their field. how these habits are used in their field, how did they learn or practice these habits, etc.)
   - How they address validity of scientific claims and theories associated with their research.
   - How they contend with federal or state agency requirements for safety regulations for themselves and other personnel, research animals and general population dangers and impact potential.
   - How they recognize the limitations of different/applicable research methodologies, technologies and limiting procedures.
   - How they question sources of information and representation of data.
   - How they recognize selective or distorted use of data, discrepancies and poor argument.
   - How they distinguish opinion from supported theory.
   - How they trace citations from research studies for validity and reliability.
   - How they report their research for peer review and juried panel review.

- How they adapt their work to advances in technology.
- How they project the impact of their research for societal or economic settings.
- How they pursue financial support for their research, etc.

5. Each student should be assigned to interview at least two scientists. The responses from the interviews may be in the form of email communications, written notes from the adult or student notes from the interview. After a reasonable period for interviews (one-two weeks), students should compile their responses to evaluate the class' selected "habits" and the conditions for scientists' work. Students should be asked to summarize the value and importance of scientific habits of mind and their own "resolutions" for personal use of them. Discuss the conditions of work reported from the interviews.
6. This activity may be revisited periodically throughout the school year in the curricular contexts of the course.
7. Evaluate each student's work using the Science Rubric as follows and add the scores to determine the performance level:
   - *Knowledge*: The foundation definitions for scientific habits of mind and the foundational requirements for their work are explained accurately and are documented.
   - *Application*: The interview process provided thorough and accurate comparisons of applications of the scientific habits of mind and conditions for research work.
   - *Communication*: The interview findings and generalizations were thorough, logical and well-detailed, showing the common and unique habits of mind and conditions for work among scientists.

Examples of Student Work not available

Resources

- Access to scientists (via internet, etc.)
- Science Rubric

Time Requirements

- 1-2 class periods to determine process parameters; 1-2 weeks for interview and preparation for class generalizations; 2-3 days for class generalizations and reflections