Handout

Five Facets of Science

(A) Nature of science

- Scientists and science teachers agree that science is a way of explaining the natural world. It is both a *body of knowledge* that represents current understanding of natural systems and a *process* through which that knowledge has been established and is being continually extended, refined, and revised (*2, Appendix H, p. 1*).
- Science is a way of looking at the world that may be distinct from other worldviews based on ethnicity, culture, and socioeconomics, including everyday ways of thinking and talking about the world (*1*).

(B) Practices of science and engineering

- Engaging in the practice of science helps students understand how scientific knowledge develops and gives them an appreciation of the range of approaches used to investigate and explain the world. The actual doing of science or engineering can help them see that the work of scientists and engineers has affected the world they live in and can contribute to meeting the challenges that confront society today (*2, Appendix F, p. 2*).
- Eight practices are considered essential for all students to learn and do in science and engineering (*3*):
    - Asking questions (for science) and defining problems (for engineering).
    - Developing and using models.
    - Planning and carrying out investigations.
    - Analyzing and interpreting data.
    - Using mathematics and computational thinking.
    - Constructing explanations (for science) and designing solutions (for engineering).
    - Engaging in argument from evidence.
    - Obtaining, evaluating, and communicating information.

(C) Culture of science

- Culture can be defined as the norms, values, beliefs, expectations, and conventional actions of a group. Using this definition, science can be considered a cultural enterprise, since scientists share a well-defined system of meaning and symbols with which they interact socially (*4–6*). Evidence is collected, interpreted, and influenced by current scientific perspectives and by the society, culture, and even the scientist's subjective opinions (*7*).
- Some philosophers of science are opposed to treating science as a cultural enterprise. They argue that such a viewpoint undermines "the universality of science"—the idea that science is the same everywhere, that science uncovers knowledge or solves problems uninfluenced by the culture, race, or gender of the individual scientist involved (*8*).

(D) Teaching the nature and practice of science

- Implicit instruction alone, about the nature of science—such as doing an investigation with no explicit reflection on the practices of science involved—is insufficient for students to develop an understanding of *what science is*. The nature and practice of science must be intentionally and explicitly integrated into instruction (*9–11*).
- Even teachers whose views on the nature of science are consistent with those advocated by current reforms in science education struggle to convey their understanding through instruction. Teachers need help to develop skills and strategies to transform their knowledge into classroom practice (*9, 12, 13*).
- Guidelines from *A Framework for K–12 Science Education* (*3*) and the *Next Generation Science Standards* (*2*) stress the importance of teaching science and engineering practices explicitly, based on disciplinary core ideas:
  - Students cannot fully understand scientific and engineering ideas without engaging in the practices of inquiry and the science and/or engineering discourses by which such ideas are developed and refined.
  - Students cannot learn or show competence in practices except in the context of specific content.

(E) Students doing and reflecting on science

- *A Framework for K–12 Science Education* (*3*) emphasizes that

  > [S]tudents must have the opportunity to stand back and reflect on how the practices [of science] contribute to the accumulation of scientific knowledge. This means, for example, that when students carry out an investigation, develop models, articulate questions, or engage in arguments, they should have opportunities to think about what they have done and why. They should be given opportunities to compare their own approaches to those of other students or professional scientists. Through this kind of reflection, they can come to understand the importance of each practice and develop a nuanced appreciation of the nature of science. (*2, Appendix H, p. 7*)

- The modeling undertaken, the arguments developed, the explanations constructed in the classroom can only ever be approximations of scientific practice. The distinction is that scientists are creating/generating/discovering new knowledge. Students rarely do that, but rather use practices that approximate what scientists do to learn what has already been created/discovered (*14*).

References

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