

## Appendix D

### Notes, Explanations and Research Base

The following information applies to all three grades—Kindergarten, First, and Second.

1. **Standard 1 is not a stand-alone piece of learning, but is designed to be integrated into the three content standards (Standards 2, 3, and 4).** The three strands of science learning included in Standard 1 are

- 1) Processes of Science,
- 2) Communication of Science, and
- 3) Nature of Science.

Teaching these process-oriented standards (Standard 1) is done most effectively while teaching the content-oriented standards (Standards 2, 3, and 4).

Standard 1 contains three Objectives. The first is from the National Research Council (NRC) definition of Inquiry [science process], the second “Communication of Science,” and the third the “Nature of Science”. When students learn through *engaging in the processes of science*, they become aware of and adept at “the processes embraced by science that allow us to extract explanation from evidence” (Johnston, 2008, p.12). Through learning science in community, through open and sustained communication, students gain deeper understandings of “norms for presenting scientific arguments . . . [and] practice productive social interactions with peers” (NRC, 2008, p.21) so that they are motivated and develop attitudes supportive of active involvement in the science classroom.

Finally, through reflecting deeply on how science knowledge is developed, students learn about the Nature of Science. The Nature of Science (NOS) “refers to . . . science as a way of knowing or the values and beliefs inherent to the development of scientific knowledge” (Lederman, 1992). Lederman (1998) explains the nuanced differences between science processes and the nature of science “Although these aspects of science overlap and interact in important ways, it is nonetheless important to distinguish the two. Scientific processes are activities related to collecting and analyzing data, and drawing conclusions (AAAS, 1990, 1993; NRC, 1996). For example, observing and inferring are scientific processes. On the other hand, the NOS refers to the epistemological [ways of knowing] underpinnings of the activities of science. As such, realizing that observations are necessarily theory-laden [or based on previous ideas] and are constrained by our perceptual apparatus [senses] belongs within the realm of the NOS”. While each objective within Standard 1 has indicators describing scientific processes, communication and nature of

science understandings that cut across all learning in grades K-2, Standard 1 is NOT taught in isolation, but instead is embedded in the teaching of Standards 2, 3, and 4.

**2. The content learning of the K-2 Science Core is found in Standards 2, 3 and 4. Standard 2 is Earth and Space Science, Standard 3 is Physical Science, and Standard 4 is Life Science.** As mentioned previously, Standard 1 is a framework, considered the vehicle through which deep foundational understandings about Standard 1 as well as Standards 2, 3, and 4 is developed. Standards 2, 3, and 4 are derived from the American Association for the Advancement of Science’s Atlas (maps) of science literacy (AAAS, 2001) and learning progression research (Catley, Lehrer, and Reiser, 2005; Plummer, 2008; Smith, Wisner, Anderson, and Krajcik, 2006) regarding how teachers can facilitate students leveraging previously acquired rich experiential understandings of the natural world to develop conceptual understandings supportive of future learning. The core concepts included in Standards 2-4 are those that are central to a discipline of science (i.e. Earth and Space Science, Physical, and Life Science), that are accessible to students in some form starting in kindergarten, and that have potential for sustained exploration across grades K-2 and beyond. Those considered important in Earth and Space Science for K-2 students are foundational features or principles about the earth and patterns of motion of the Sun, Moon, and stars (celestial motion). Those considered central to Physical Science are foundational to students understanding of atomic-molecular theory of matter and Newtonian laws of force and motion. Finally, those considered foundational to students understanding of life science are changes in organisms over time and the nature of living things. The specific grade level appropriate concepts for Standards 2-4 are outlined in the following Big Ideas for each grade level.

**3. Science, Technology and Society (STS):**

“The primary goal of science is to understand the natural and human-designed worlds. Science refers to certain processes used by humans for obtaining knowledge about nature, and to an organized body of knowledge about nature obtained by these processes. Science is a dynamic and creative activity with a long and interesting history. Many societies have contributed to the development of scientific knowledge and understanding...Scientists continuously assess and judge the soundness of scientific knowledge claims by testing laws and theories, and modifying them in light of compelling new evidence or a re-conceptualization of existing evidence.

“Technology involves the development and use of materials, tools, and processes for solving human problems and helping to satisfy human needs and desires. Many of the products of technology help humans accomplish tasks that would otherwise be very difficult or impossible to carry out. Although technology provides many benefits, it also produces associated costs and risks. Science often uses and requires tools and processes developed by technology, and conversely, technology often employs

principles, laws, theories, and processes developed by science. SCCAO and STAO/APSO, “Position Paper: The Nature of Science” (2006), pp. 1–2.

As can be seen from these two descriptions science and technology are inextricably linked. But, according to the National Science Education Standards, it is important to help students “establish connections between the natural and designed worlds and provide students with opportunities to develop decision-making abilities. STS is included in the K-2 core, not as a stand-alone standard, but as guidance for teachers to help students engage the learning in Standards 2-4. STS guidance at each grade level focuses on the 1) Tools (T) used in ‘doing science’, 2) Applications (A) of science to enhance technology or of technology to enhance the processes of science, and 3) Implications (S) of science and technological applications in students lives (e.g., benefits, constraints, consequences, risks).

4. **Objectives are selected to support the teaching of Big Ideas** in science, which are organized by Standard. Big ideas “go beyond discrete facts or skills to focus on larger concepts, principles, or processes” (Grant Wiggins and Jay McTighe, *Understanding by Design*, 1998, p. 10). Big Ideas are cumulative, meaning that students revisit ideas that are previously developed, but in more and more complex ways at each successive grade level. This allows teachers to anchor learning at the beginning of the grade level to “concepts and reasoning abilities that young children bring with them” (NRC, 2008).
5. **Indicators are selected as the Measureable Outcomes of each objective.** They describe measureable, observable actions that not only show content mastery but also mastery of the scientific processes in Standard 1. Indicators are not intended to reflect all the learning that an objective implies. They support both the content standard Big Ideas and the Standard 1 Big Ideas.