Appendix E

Our Four Principles of Inquiry

**Principle #1: Inquiry-Based Learning Begins with an Inquiry Question.**

Each lesson seeks to answer one or more inquiry questions about concepts or relationships in science. Inquiry questions (e.g., “What kinds of materials stick to a magnet?”) provide an overall purpose for the entire lesson, and may be generated by the teacher or the students. These questions should be explicitly stated using language that is easily understandable.

*Corollary 1.1: In general, since inquiry-based science is not intended to be a review of familiar ideas, students should not already know the answers to the inquiry questions.*

*Corollary 1.2: Inquiry questions are different from the questions that teachers routinely pose to the class or to individual students during an inquiry science lesson (e.g., "What do you know about magnets?", "Why do you think that happened?").*

**Principle #2: Inquiry-Based Learning Is Student Centered.**

Students are the center of the learning process. The instructor provides varying degrees of structure and guidance during the lesson (e.g., by providing materials, asking good questions, and holding discussions). However, it is the students (individually, as a small group, or as an entire class) who are ultimately expected to answer the inquiry question(s) on their own. In addition, whenever possible, the teacher allows students to engage in hands-on scientific activities themselves, rather than doing these for the students as a demonstration.

*Corollary 2.1:  The teacher does not explain answers to inquiry questions (e.g., via lecture or reading books) for students prior to students answering the questions for themselves.*

*Corollary 2.2: The students must be allowed sufficient time for discussion and reflection to formulate their own answers to inquiry questions.*

*Corollary 2.3: The teacher provides explanations and answers only when absolutely necessary.  After the students have already come to a consensus on the answers to the inquiry question, it is appropriate for the teacher to help the class clarify and elaborate upon these answers, as well as to introduce scientific terminology and definitions. Such clarification or elaboration may take a variety of forms, including short lecture, reading books, or watching videos.*

**Principle #3: Inquiry-Based Learning Involves Deep Thinking about the Answers to Inquiry Questions.**

Lessons should prompt students to think deeply about scientific concepts and relationships. This can be accomplished through small-group and whole-class discussions, hands-on experiments (which are often cooperative), reading texts to generate questions, and other means.

*Corollary 3.1: Deep thinking should occur in all aspects of inquiry-based science, including the sharing of initial ideas, participation in hands-on science activities, the presentation and discussion of scientific observations (i.e., scientific data), and the eventual answering of the inquiry question(s).*

*Corollary 3.2: Scientific experiments are not the only activities that can support deep thinking. For example, having students draw and discuss space suit design is a perfectly acceptable avenue for thinking about the properties of space in an inquiry-based manner.*

*Corollary 3.3: Inquiry-based lessons should not solely or primarily consist of hands-on activities that do not support deep thinking about science. For example, while making mobiles about the stages of frog growth may be an appropriate part of a science lesson on frog development, in and of itself it would not constitute an inquiry-based lesson.*

*Corollary 3.4: Inquiry-based lessons do not focus on the memorization of right answers and vocabulary words.*

**Principle #4:  Inquiry-Based Learning Emphasizes Evidence-Based Reasoning.**

Students are encouraged to provide evidence and reasoning for their predictions, observations and their answers to inquiry questions. This evidence will draw upon everyday experience, experimental data, common sense, and prior knowledge. Students are frequently asked to answer questions like, "Why do you think that?" or "Can you explain your reasoning?"

*Corollary 4.1: One purpose of encouraging students to use evidence during scientific experimentation is to revisit and revise their scientific ideas.*

*Corollary 4.2: Teachers should ask students to share evidence both verbally and in written form.*