**A Vision for Science Education in the Hopkinton Elementary Schools:**

During the summer of 2011, a committee of elementary, middle, and high school teachers met to review and examine science curriculum in the Hopkinton elementary schools. As a result of their efforts, the following document was crafted to help provide guidance and set expectations for the instruction of science in the Hopkinton School District. The following excerpt from the National Academy of Sciences best summarizes the philosophy and research which is reflected in the work of the committee:

***PRINCIPLES OF THE FRAMEWORK:***

*The committee considered many guiding principles, drawn from what is known about the nature of learning science, which underlie both the structure and the content of the framework. These principles include young children’s capacity to learn science, a focus on core ideas, the development of true understanding over time, the consideration both of knowledge and practice, the linkage of science education to students’ interests and experiences.*

***Children Are Born Investigators***

*Research has revealed that children entering kindergarten have surprisingly sophisticated ways of thinking about the world, based on in part on their direct experiences with the physical environment, such as watching objects fall or collide and observing plants and animals They also learn about the world through everyday activities, such as talking with their families, pursuing hobbies, watching television, and playing with friends. As children try to understand and influence the world around them, they develop ideas about their role in that world and how it works. In fact, the capacity of young children to reason in sophisticated ways is much greater than has long been assumed. Although they may lack deep knowledge and extensive experience, they often engage in a wide range of subtle and complex reasoning about the world. Thus, before they even enter school, children have developed their own ideas about the physical, biological, and social worlds and how they work. By listening to and taking these ideas seriously, educators can build on what children already know and can do. Such initial ideas may be more or less cohesive and sometimes may be incorrect. However, some of children’s early intuitions about the world can be used as a foundation to build remarkable understanding, even in the earliest grades. Indeed, both building on and refining prior conceptions (which can include misconceptions) is important in teaching science at any grade level. The implication of these findings for the framework is that building progressively more sophisticated explanations of natural phenomena is central throughout K-6, as opposed to focusing only on description in the early grades and leaving explanation to the later grades.*

***Focusing on Core Ideas and Practices***

*The framework focuses on a limited set of core ideas in order to avoid the coverage of multiple disconnected topics—the oft-mentioned mile wide and inch deep. This focus allows for deep exploration of important concepts, as well as time for students to develop meaningful understanding, to actually practice science and engineering, and to reflect on their nature. It also results in a science education that extends in a more coherent way across grades K-12.*

*The core ideas also can provide an organizational structure for the acquisition of new knowledge. Understanding the core ideas and engaging in the scientific and engineering practices helps to prepare students for broader understanding, and deeper levels of scientific and engineering investigation, later on—in high school, college, and beyond. One rationale for organizing content around core ideas comes from studies comparing experts and novices in any field. Experts understand the core principles and theoretical constructs of their field, and they use them to make sense of new information or tackle novel problems. Novices, in contrast, tend to hold disconnected and even contradictory bits of knowledge as isolated facts and struggle to find a way to organize and integrate them. The assumption, then, is that helping students learn the core ideas through engaging in scientific and engineering practices will enable them to become less like novices and more like experts. Importantly, this approach will also help students build the capacity to develop more flexible and coherent—that is, wide-ranging—understanding of science. Research on learning shows that supporting development of this kind of understanding is challenging, but it is aided by explicit instructional support that stresses connections across different activities and learning experiences.*

***Understanding Develops Over Time***

*To develop a thorough understanding of scientific explanations of the world, students need sustained opportunities to work with and develop the underlying ideas and to appreciate those ideas’ interconnections over a period of years rather than weeks or months. This sense of development has been conceptualized in the idea of learning progressions. If mastery of a core idea in a science discipline is the ultimate educational destination, then well-designed learning progressions provide a map of the routes that can be taken to reach that destination. Such progressions describe both how students’ understanding of the idea matures over time and the instructional supports and experiences that are needed for them to make progress. Learning progressions may extend all the way from preschool to 12th grade and beyond—indeed, people can continue learning about scientific core ideas their entire lives. Because learning progressions extend over multiple years, they can prompt educators to consider how topics are presented at each grade level so that they build on prior understanding and can support increasingly sophisticated learning. Hence, core ideas and their related learning progressions are key organizing principles for the design of the framework.*

***Science Requires Both Knowledge and Practice***

*Science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge. Both elements—knowledge and practice—are essential.*

*In science, knowledge, based on evidence from many investigations, is integrated into highly developed and well-tested theories that can explain bodies of data and predict outcomes of further investigations. Although the practices used to develop scientific theories (as well as the form that those theories take) differ from one domain of science to another, all sciences share certain common features at the core of their inquiry-based and problem-solving approaches. Chief among these features is a commitment to data and evidence as the foundation for developing claims. The argumentation and analysis that relate evidence and theory are also essential features of science; scientists need to be able to examine, review, and evaluate their own knowledge and ideas and critique those of others. Argumentation and analysis include appraisal of data quality, modeling of theories, development of new testable questions from those models, and modification of theories and models as evidence indicates they are needed.*

*Finally, science is fundamentally a social enterprise, and scientific knowledge advances through collaboration and in the context of a social system with well-developed norms.*

*Individual scientists may do much of their work independently or they may collaborate closely with colleagues. Thus, new ideas can be the product of one mind or many working together. However, the theories, models, instruments, and methods for collecting and displaying data, as well as the norms for building arguments from evidence, are developed collectively in a vast network of scientists working together over extended periods. As they carry out their research, scientists talk frequently with their colleagues, both formally and informally. They exchange emails, engage in discussions at conferences, share research techniques and analytical procedures, and present and respond to ideas via publication in journals and books. In short, scientists constitute a community whose members work together to build a body of evidence and devise and test theories. In addition, this community and its culture exist in the larger social and economic context of their place and time, and are influenced by events, needs, and norms from outside science, as well as by the interests and desires of scientists.*

***Connecting to Students’ Interests and Experiences***

*A rich science education has the potential to capture students’ sense of wonder about the world and to spark their desire to continue learning about science throughout their lives. Research suggests that personal interest, experience, and enthusiasm—critical to children’s learning of science at school or other settings—may also be linked to later educational and career choices. Thus, in order for students to develop a sustained attraction to science and for them to appreciate the many ways in which it is pertinent to their daily lives, classroom-learning experiences in science need to connect with their own interests and experiences.*

*As a strategy for building on prior interest, the disciplinary core ideas identified here are described not only with an eye toward the knowledge that students bring with them to school but also toward the kinds of questions they are likely to pose themselves at different ages. Such questions as “Where do we come from?” “Why is the sky blue?” and “What is the smallest piece of matter?” are fundamental hooks that engage young people. Framing a curriculum around such sets of questions helps to communicate relevance and salience to this audience.*

With these key principles in focus, the committee constructed the “Power Standards” for each grade level in a framework that both accounts for the questions, “what do we want each child to know and to be able to do” in relation to science for grades K-6. It was the intention of the committee to establish this framework so that common assessments might be created which help define student learning.

Within the frameworks, the committee utilized current professional thinking in relation to crosscutting concepts in science as a means to classify who and why content is being presented to children. The intention of the committee was to assist the teacher in helping to define the context in which the content was being presented. Within the K-6 framework, the following crosscutting concepts were identified and used for classification of content:

**Crosscutting Concepts**

1. Change
2. Interrelationships
3. Scale
4. Modeling
5. Inquiry / Process

**How to Use the Frameworks:**

The intention of the frameworks is to provide teachers with knowledge of the District’s expectations for science content delivery at each grade level K-6. While the frameworks do not articulate specific content required to address the flow of the curriculum, it provides the teacher with the “Power Standard” which represents the key concepts that are presented for mastery at each grade level. As the teacher examines the “Power Standard”, it is critical that s/he examines the contextual theme with which it is being identified and emphasizes this theme through instructional practice and methodology.