



Empowering Teachers. Engaging Students.

## **Learning Science Through Scientific Practices and a Process of Inquiry**

Van Andel Education Institute (VAEI) developed the VAEI Community of Practice (CoP) model for science instruction based on research findings that optimal learning of science occurs through a process of inquiry. CoP incorporates the tenets advocated by, among others, Project 2061, the American Association for the Advancement of Science, the National Science Education Standards, and the National Research Council (NRC).

To enable students to learn science through scientific practices and a process of inquiry, our instructional model supports the six strands of scientific proficiency as identified by the National Research Council (*Taking Science to School*, 2007; *Learning Science in Informal Environments*, 2009; *A Framework for K-12 Science Education*, 2012):

1. Experience excitement, interest and a motivation to learn about phenomena in the natural and physical world
2. Know, use, and interpret scientific explanations of the natural world
3. Generate and evaluate scientific evidence and explanations
4. Understand the nature and development of scientific knowledge
5. Participate productively in scientific practices and discourse
6. Think of self as a science learner and develop an identity as someone who knows about, uses, and sometimes contributes to science.

As put forth in *Taking Science to School* (pp 36-38):

... understanding science is multifaceted ... proficiency in one aspect of science is closely related to proficiency in others ... the strands of scientific proficiency are interwoven and, taken together, are viewed as science as practice (see Lehrer and Schauble 2006) ... learning science involves learning a system of interconnected ways of thinking in a social context to accomplish the goal of working with and understanding scientific ideas.

VAEI further synthesizes the six strands within a community of scientific practice context. As identified by Wenger (2006) three crucial characteristics of a community of practice are the domain, the community, and the practice. VAEI's community of scientific practice context delineates the domain as working with and understanding scientific ideas; the community as interacting and learning together in a socially and language rich environment; and the practice as utilizing a process of scientific inquiry while nurturing habits of mind.

## **Establish a Socially and Language Rich Environment**

The educational environment is an important influence on how students view themselves as science learners and whether they feel supported to participate fully in the scientific community of the classroom. While engaging in inquiry involves a great deal of activity that is under students' control, establishing a supportive environment for inquiry-based scientific learning to realize its full potential is primarily under the teacher's control. Using VAEI CoP, teachers create an environment that is both socially rich and language rich. They encourage a culture of cooperative interactions within a variety of collaborative structures, shared control between themselves and the students, and oral and written discourse. Questioning, respect, and risk-taking are valued and reinforced. Norms are established for self-direction as well as for encouraging expression of ideas and the risk-taking that can entail. As defined in *How People Learn* (2000), VAEI CoP designs the learning environment to be learner-centered, knowledge-centered, assessment-centered, and community-centered. The culture created and fostered in our socially and language rich environment is a culture of being community-centered. We put a great deal of emphasis on the ideas and understandings that students bring to the classroom. We plan activities or discussions to determine both what students know and how they know it. We engage students' ideas. This describes being learner-centered. We view opportunities for inquiry as the method for learning the science content. Inquiry is not just tacked onto the content. Our programs are knowledge-centered.

## **Utilize a Process of Scientific Inquiry: QPOE<sub>2</sub>**

Scientific content, concepts, and process are not independent or separable in the practice of science, nor in the teaching and learning of science. Scientific content, concepts, and process are inherently linked and should not be taught separately. VAEI developed and utilizes a mnemonic, "QPOE<sub>2</sub>", a framework for scientific investigation and discourse that provides scaffolding to guide students through their scientific inquiry. QPOE<sub>2</sub> expands the commonly known and widely used POE: Predict, Observe, and Explain.

As designed by VAEI, Q is for Question. Instruction is organized around doable/testable, important, interesting and ethical Questions that can be tested empirically. Questions are generated by both the instructor and the students. P is for Prediction. The Prediction is the expected outcome of an investigation, at a given point in the investigation process. Prior knowledge and experience is activated, represented and used to help formulate the Prediction. O is for Observation. Students gather and organize data using their five senses (qualitative Observations) and using counts or measurements (quantitative Observations). The VAEI process of scientific inquiry has two "E's". The first E is for Explanation. The focus is on students making sense of their Observations. They summarize, clarify and defend. Student Explanations provide their claim based on the evidence they collected, supported by sound reasoning. (The three components: claim, evidence, and reasoning, parallel the construct as developed by Toulmin, Krajick, and McNeill.) Breaking Explanations into components can help students create cohesive arguments. The second E is for Evaluation. Students self-assess the quality of their research skills used in gathering their data. Students are guided through the Evaluation of QPOE<sub>2</sub> with a series of Questions, such as "What are the sources of error?" "How confident are you in your results?" "What would you do differently next time?" But Evaluation does not occur only at the end of an

investigation. At every stage of QPOE<sub>2</sub>, students are guided through an Evaluation of that stage. Our design is replete with formative assessment. Our design is assessment-centered.

### **Nurture Habits of Mind**

VAEI CoP regards the nurturing of habits of mind (21<sup>st</sup> century skills) as fundamental for improved learning of science. Though not a complete list of the habits of mind, we have identified eight to be cultivated: curiosity, openness to new ideas/informed skepticism, creative thinking, critical thinking, persistence, adaptability, self-direction, and integrity. These abilities are significant in their own right of what it means to be science-literate. VAEI CoP fosters these habits of mind by enabling students to pursue scientific questions that truly interest them, incorporating individual and group projects, requiring explanations be supported by evidence and sound reasoning, providing opportunities for scientific argument and debate, encouraging alternative explanations, and emphasizing that science involves the processes of imagination and creativity.

VAEI CoP combines a socially and language rich environment with a process of scientific inquiry while nurturing habits of mind. The locus of control is moved away from the instructor to the students. CoP promotes students interacting in meaningful ways. Students learn science within a community of scientific practice. This more closely resembles the work of scientists.

NexGen Inquiry ([www.nexgeninquiry.org](http://www.nexgeninquiry.org)) is a digital teaching and learning platform providing teachers and students with ready access to tools and resources supporting classroom implementation of VAEI CoP, including:

- interactive, cloud-based software for teachers and students,
- professional development videos for teachers,
- an online community where teachers can interact with each other and NexGen staff to share ideas and obtain support for CoP implementation, and
- a resource library with vetted lessons and resource materials.

### References

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