EDITORIAL

Process Skills and Content Knowledge

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Which is more important, science process skills or content knowledge? Science process skills drive the doing of science; science content is the knowing of science. How teachers answer this question can have dramatic implications for the science experiences that they choose for their students.

I consider any ability that helps a person do science to be a science process skill, whether it is observing, inferring, classifying, questioning, predicting, experimenting, data analyzing, or communicating. For example, nurses make keen observations, engineers analyze data, and scientists experiment. Learning such skills is not only important for those who pursue a science-related career. It is difficult to imagine a job in the next millennium that will not involve using science process skills. Transcending science lessons, process skills help children read, write, and do social studies and mathematics. They are important in school, in the workplace, and in life.

The body of knowledge generated from scientific inquiry is called *science content*. These theories, laws, ideas, and facts are important, and I hope the importance of this acquisition of knowledge will not be lost as teachers are pressured to teach content only to improve performance on standardized exams. In the past, teachers have consistently said that they teach science content to prepare students for higher learning. Teachers must find a greater rationale for teaching science content. I hope they will see that teaching science content is important in its own right.

People working in science need to know the body of knowledge that pertains to their field. Engineers should understand stress and strain in materials before they design a structure. Doctors should understand the workings of the human body and diseases before they examine a patient. Apart from being critical for students pursuing science careers, science content gives everyone insights into the workings of the universe, the biosphere, and the human body. Citizens can better make difficult choices regarding the health of their bodies and the health of our planet. It is absurd to imagine a scientist with no content knowledge or a scientist with no science process skills; the two are complementary. Many students will not become scientists, but everyone is a citizen. We want citizens who understand many aspects of the world, who can make observations, ask questions, and analyze data.

Is it necessary to choose skills over content or vice versa? In my opinion, they are both essential elements of science education. While science process skills are necessary to do science, they also promote an understanding of the nature of science, and they help students appreciate the origin of facts. Science content provides a launch pad for further explanation. For example, Isaac Newton could contribute new learning because, as he put it, he stood on the shoulders of giants. The work done by previous scientists gave him the knowledge so he could go further.

The power of activity-based learning is that it offers a context for both science process skills and content. The articles in this issue show how all three components are important for students to have effective science experiences. Context is established, for example, with a question such as How many stars are there in the sky? Shin uses this question to entice high school students to learn processes and content in astronomy. Although the heavens are an important context, it is equally important to look at ordinary things in imaginative new ways. Glime and Li's cation activity, with its hands-on approach to studying the pH factor of *Sphagnum*, lets students embark on a journey of process skill and content learning in botany and chemistry.

Pettus provides a context that simulates underwater mapping. By first learning how bathymetric maps are created, students develop a better understanding of the information held in these maps. Shimberg and Grant show us that the

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study of forensics includes context, process, and content. Within the context of given incriminating evidence, an expert with a knowledge of forensics can use certain processes to solve a crime.

In conclusion, science content and science process skills are equally valuable; the learning of one aids the learning of the other. Providing a context for science education makes the learning more interesting, motivating, and powerful. This can lead some students to pursue science careers and help all students to experience more fulfilling lives.