NCEA® RESOURCE

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STEM Education: Giving Your Students Presents

Try to remember yourself as a child with a wrapped present in your grasp. A relative or friend has gone to the trouble of not only getting you a gift, but of obscuring it with cardboard and paper to create the kind of mystery that consumes an impatient child.

Driven, you look for ways to gather information about the contents of the tantalizing package. How about considering its size (about a half a meter squared… definitely not a bicycle!); is it longer than wide? (might be a… But no, you've been fooled before!); sometimes the shape of the box can be misleading.

Looking alone won't solve the mystery. How heavy is it? You shake it, you rattle the box. You still can't be sure. You can speculate, but that makes the desire to know more intense than anything else.

What are your options now? You could beg the gift-giver to tell you what's in the box, but you wouldn't know if they were telling the truth. In the end, to be completely sure and completely satisfied, you simply have to open it.

When you do, you can see what made that high-pitched rattle when you shook the box. You can see that what you supposed was a fairly large item is actually much smaller than you suspected but encased in many layers of protective padding. Only now, with the box open, do you really know what is in the box. Regardless of how many presents we receive, we always guess at what might be inside each new one and we always enjoy opening the boxes to find if we were right. Why can't we approach teaching our students science in a way that taps into this extraordinary desire to know the unknown? Why can't we use a science curriculum that piques a student's curiosity to a degree that they are driven to discover for themselves the contents of the "box": the answer to a mystery? We can.

Wrapping the Present

The key to giving students the joy of solving a science mystery is to begin by planting questions. No questions, no mystery. When we feed students answers alone, we will have a hard time convincing them that we are giving them a present at all. It's akin to showing up at a birthday party with a blue sweater on and then taking it off and handing to the guest of honor. Even if they like it, you have sure taken the fun out of presenting the gift.

It is the questions that we develop in a student's mind about a science concept that serves as the box and wrapping paper. Good, intriguing questions stimulate more thoughts and speculation than drab mechanical ones. "Why is respiration important?" is not the same as asking "How long can you hold your breath?" Intriguing questions are the odd-shaped boxes and brightly colored paper of science education. They attract student attention. They create the mystery.

To be effective, science questions have to be meaningful to students. At a minimum, they should relate to something – a phenomenon, an observation – which the student has likely experienced in some fashion already. Better still, something they will likely encounter today and again tomorrow in the real world.

Provide interesting science questions without furnishing the answers. Devote classroom discussion to pure speculation. If you don't think real scientists do exactly the same thing, drop by a university or research

corporation cafeteria and eavesdrop on a table of scientists – you will hear 90% speculation at a minimum. Let students pick sides, guess, and speculate for themselves. When they speculate, all you need to do at this point is say, "Are you sure?" or "How can you be sure?" or "Does everyone agree with Keith?" Don't worry about providing the answer. In particular, don't worry if you hear the wrong answer. All the better for cognitive imprinting when students find the correct answer for themselves in the next and most exciting part of the gift-giving process.

LabLearner students at Blessed Trinity Catholic School in the Archdiocese of Philadelphia.

Unwrapping the Present

If we think of the scientific research and experimentation that goes on in nearly each and every laboratory in the world as the unwrapping presents, one can appreciate why science is one of the most exciting and rewarding professions imaginable. For scientists, everyday frustration and dead ends serve only to heighten and intensify the satisfaction of scientific discovery. It can be the same way for our students.

Science education must be accomplished by hands-on laboratory experience. I cannot overemphasize this. The hands-on science experience must be the heart, the soul of the science curriculum, not an add-on at the end of long textbook chapters. Everything should revolve around personal experience and discovery. If you were presented with a wonderfully wrapped gift, how satisfying would it be for someone else to rattle the box and tell you how it felt or what sounds he or she heard? Which would be more meaningful, fulfilling, and memorable - tearing off the wrapping paper yourself or having someone else open a present in the next room and then bring it to you? The answer is obvious. Reading about science is fundamentally inferior to hands-on discovery and learning. From a neurocognitive perspective, there is no comparison. Reading about opening a gift is not the same as opening one yourself – it is that simple.

Beyond the tactile stimulation of you, yourself opening the gift also comes the step-by-step discovery of the content's identity. You strip back the layers and see one small part at a time. And, most importantly, by degrees reality confirms or contradicts your speculations and guesses – your hypotheses and predictions.

During the PreK-12 experience, students should be given and permitted to open hundreds of such science presents. The entire, multi-year science curriculum should be accomplished by a constant diet of them. Presents about speed, growth, explosive power, and reactions. Presents about Big Bangs, stars, flesh-eating dinosaurs, and nasty little parasites.

Ultimately, the most significant aspect of the science "presents" we give our students is the scientific skills and way of thinking that they develop in the process of opening them. Science can be an exercise in mystery-solving, contemplation and discovery. Answering one's own questions, questions that you really what to know the answers to, not only engenders satisfaction and affirmation of our students' cognitive powers, it is also exciting and just plain fun.

An Invitation to the Party

Over the course of several NCEA webinars, papers and a book on STEM in Catholic schools, we will delve deep into the neurocognitive aspects of teaching and learning STEM. We will discuss brain structure and function as it directly relates to classroom practice. We will evaluate for ourselves the logical extensions of modern neuroscience into how we approach our jobs as educators. It will be a fun and intriguing journey of discovery for seasoned teachers and novices alike. It will, in fact, be a series of intellectual presents that we will open together. After all, we all like presents, don't we?

Dr. Keith Verner
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