Making Sense of Science

Creative approach leads to new perspectives and discoveries

By Dewey Dykstra

Science is about making sensible, useful explanations of the phenomena of the world around us. This is a fundamentally creative act. While scientists have invested much personal time in developing their skills, their thinking is essentially a refinement of something we all are born with. Making sense of the world around us is a basic capability of all human beings. Please consider these two vignettes about the "science" we learn.

Imagine that you are presented with a lens and an unfrosted light bulb with a brightly glowing, shaped filament. Both are arranged so that a bright, crisp image of the filament appears on a nearby flat surface. What do you think would happen to the image on the screen when the top half of the lens is covered by an opaque card?

Please stop and search your own personal ideas. Make a sketch of what you think happens and describe it in words. Make some notes about why your answer seems reasonable. Compare your ideas with a friend, if possible.

Now imagine that when you actually try this demonstration, instead of half of the image disappearing, the whole image remains but gets a bit dimmer. Do your notions about light rays, lenses and images explain or support what seems to have happened? Are you curious about what is going on here?

For the next example, imagine you have before you a small seed from a maple tree, and a large piece of wood split from the tree's trunk. Where do you suppose all the matter that the tree is made of comes from? What is it made of?

Please stop reading again and think of what answer makes sense to you and why. It may help to think about where the matter comes from that a tree uses to grow and not about processes that might make this possible. Again, compare your ideas with a friend, if possible.

As it turns out, 300 or so years ago a fellow by the name of von Helmut took a large pot of soil, dried the soil and weighed it. Then he planted a willow in the pot and took care of the plant while it grew for five years. At the end of this time he carefully removed the plant, separating it from the soil, and then dried and weighed the soil. He also weighed the plant. He found that while the plant had gained 170 pounds, the soil lost only two or three ounces. If the plant doesn't come from the soil, then is it mostly water? What else could it be? Are you curious about what is going on here?

Sadly, just about all of us were taught about light rays in school. We've all seen the picture of the sun or a light bulb with straight lines radiating out from the surface and read or heard something to the effect that light rays go out in all directions. We have all been taught about plants and photosynthesis. Yet, most of us are unprepared to explain the outcome of these simple demonstrations that do not match our predictions most of us made quite comfortably and confidently. It is not a matter of "knowing the facts," but a matter of having encountered similar discrepancies and having created for ourselves new or modified explanations to account for them.

Earlier in the 20th century it was noticed that babes-in-arms apparently figure out the concept that objects continue to exist even when not directly perceived. They are not born with this concept. Since the beginning of humankind, children have been figuring out what language is and learning one without having anyone to explain it to them because they have no language to start

with. These are but two of the profound intellectual acts, the soaring feats of conceptual creation, accomplished by one and all at a tender age.

By the time we are in high school or college, most of us are saying we're not "good" in science and we can't learn a second language. At the same time research over the last two decades has shown time and again that students' perceptions of the world hardly change in normal science instruction. We're taught that some of us are just not good at science. After all science is hard. Not everybody can do it well. Right? Yet, the evidence is that we are all born with tremendous capacity to make sense of the world around us.

Maybe it's not our incapacity but the incapacities of the practices of teaching. This is not to say that teachers and professors do not mean well by their students. It is just to point out the results of science teaching. Despite the sincere good intentions of science teachers, the outcome is that the capacity to perform the creative act of making sense of the world is severely atrophied. Even more importantly, the belief in one's ability to perform such a creative act is eliminated. All the while our notions about the world and how it works hardly change at all.

Instructional practices emphasize facts, skills and vocabulary without ever engaging students in personal and collective sense-making. These practices reward fast answers and quick guesses. How can such practices be expected to do anything but develop a dependency on others for the "truth" and a reduced self-image of most of the students? Does it help when on top of these practices we add institutionalized testing of these facts, skills and vocabulary to rate student, teacher and school?

Instead of being about facts and truth, school science should be about wondering about the phenomena and making sense of them. It should be about question marks instead of periods and exclamation points. Are there real examples of this kind of science and math instruction? Most certainly, but sadly only a few. Much more common is a model of instruction based on answering questions, instead of exploring and testing possible explanations.

But it doesn't have to be that way. Start with a light bulb and lens, a maple seed and a block of wood, or anything else that captures your imagination. Look for things that do not behave as you expect. Only from these come reasons to create and test new explanations — reasons to do the creative act of science.

Dykstra, a Boise State physics professor, has studied what makes students understand and learn. He and a colleague at Carnegie-Mellon University were recipients of a $416,000 grant from the National Science Foundation in 1989 to develop a computer program to aid in diagnosing students' problem-solving methods. Dykstra would be glad to discuss the ideas in this article further and provide references. You can reach him by phone at (208) 426-3105 or by e-mail: dykstrad@email.boisestate.edu.

CHUCK SCHULER PHOTO

Teacher education professors Rule, left, and Rogien advocate creativity, as seen in the masks made by Rule.

CREATIVITY

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She also disagrees with the criticism that too many teachers are overly concerned about making sure their students meet standards and pay little if any attention to creativity.

"I think most of us try to foster creativity when we can," she says. "It's a real balancing act, but that's part of the challenge. I'd hate my job if I couldn't be creative; I think most of us feel that way."

But Boise State teacher education professor Robert Bahruth contends that not enough teachers are flexible enough to encourage creativity in their classrooms. And from his perspective, an even bigger problem than standardized testing is competitive grading and the need to memorize facts to get good grades.

"An 'A' has nothing to do with creative thinking," he says. "An 'A' has to do with how well you please the teacher. It's a conformity issue."

Bahruth maintains that the need to assign grades stifles creativity, victimizing students and teachers as well. "It's a one-size-fits-all kind of learning, and in my opinion neither the teacher nor the student benefits."

The emphasis on memorization, says Bahruth, robs students of the opportunity to contemplate their ideas critically or to discuss them in the classroom. "What you get are identical products that conform, that don't question authority and don't deviate from the instruction given," asserts Bahruth. "How can anyone be creative in that kind of atmosphere? Learning and being creative should be about asking good questions rather than looking for the 'official' right answer."

Rule agrees. "It's that very rigid, we-all-do-everything-at-the-same-time approach that kills creativity and kills curiosity," she says. "Of course you have to have a curriculum. But the application of what exactly a teacher chooses to use and how he or she decides to implement the curriculum should be guided by what is in the best interest of the students."

Another reason why kids seem less creative as they grow older is the simple maturation process of a young human being — where an impressionable first-grader grows up, develops social skills, begins to comprehend life's realities and gradually develops into an eighth-grader who views the world with less wide-eyed wonder. It's further proof why schools and teachers should not have to shoulder all the blame for the perception that many students lack creative impetus, says the Boise School District's Holmes.

"Young children, especially kindergarten age and below, have a less clear distinction between reality and fantasy," she says.

Therefore, they are more likely to be creative and share their thoughts because they don't have the sense that their peers are sitting there, ready to pounce on their "stupid ideas."

But as youngsters mature, they begin to put limits on themselves and become sensitive to other kids' feedback. "Seventh- and eight-graders still have very vivid imaginations," Holmes says. "But they are more careful of what they say because they imagine a peer audience."

So how does a teacher foster creativity among his or her students — especially those in the higher grades?

"By having activities that give students ownership," responds Rule. "Sure they have to have some skills, but they need to make choices."

"By allowing students choices," replies Rogien. "But by giving them choices that allow them to demonstrate knowledge."

And exercise creativity. ❑