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Question Their Answers

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Brenda Royce has been teaching high school chemistry and physics for nine years, and is currently science department chair at University High School in Fresno, CA, a college prep charter school on the CSU Fresno campus. She also enjoys coaching Science Olympiad, and working with science and math student teachers as a workshop leader and mentor teacher through the Science and Math Education Center at CSUF. Prior to teaching, she worked in analytical and environmental chemistry for several years. Brenda shares with us her strategy of answering students' questions by "questioning their answers."

Questions—our classrooms thrive on questions. We answer students' questions with clear explanations so they can learn. The students answer our questions to demonstrate their understanding. Or so I believed when I started out my teaching.

"Mrs. Royce, I'm not sure about this question—did I do it right?" a student asks about an assignment. "Great teaching opportunity," I think. "She's asking for information." Patiently I look at her work and, finding where the confusion is, I begin to explain the correct way to think about the question. When I'm done, I check back to see if my explanation makes sense. She seems to understand; she answers correctly. I'm teaching and she's learning, right? Except, we've been discussing this concept for several days. And on the test she is still confused by the same idea in a different question. And it's not just this one student.

As a beginning teacher, I thought the art of teaching was in the art of great activities with clear explanations. If I explained it clearly enough using engaging activities, my students would get it and keep it. Why, then, was I repeatedly explaining the same idea? Why, at the end of clearly written and explained labs, which students "successfully" carried out, could many students only vaguely describe the main idea of the lab?

After about three years of teaching I knew enough to know I didn't know enough. At that point, I was challenged to change how I think about teaching through an opportunity to participate in a training workshop on Modeling Physics. During the workshop and, most importantly, in my classroom, it became evident that it is not the quality of *my* words that determine the quality of my students' understanding. It's the quality of *their* words in describing core ideas that counts. I began to see my job as engaging them in a way that gets them to articulate their understanding, to look more deeply at their thinking, and to not stop with the first right answer. One key secret to this I've learned is not in my *explanations* but in my *questions*.

If our students are really going to learn deeply, they must think deeply, and as good human beings they generally won't work harder at that than asked. So how do we keep the thinking going? How do we know if there is understanding behind the answers?

When a student gives an answer, I've learned to listen for understanding and follow up with a question or two that will reveal depth. When students ask a question, it's my job to guide with well-crafted questions so they can explain what they already understand and build on that to better understanding.

Now when that same questioning student approaches, it sounds more like this:

Student: "Mrs. Royce, I'm not sure about this question. Did I do it right?"

Teacher: "Tell me what you did." [*Student response*]

–"Why did you choose that approach?" [*Student response; uncertain*]

–"Can you tell me what this part of the question (suspected point of confusion) is describing? What would that mean?" [*Student response*]

–"So, how would you represent this situation in a graph/equation/diagram?" [*Student response; corrects work*]

–"Now, according to your answer, what would we see happening?" [*Student response*]

–"How does that fit your experience (or, what we saw in the lab)?" [*Student response*]

–"How would your answer be different if...?" [*Student response*]

–"Tell me how you predicted this." [*Student response*]

The students are invited to share their thinking and go beyond just getting the answer. They are asked to connect the question to principles and experience, to predict the effect of changes. I see more light bulbs go on through this kind of dialog than I ever did with my best explanations however clearly and sincerely given. Questioning takes time—and practice. It must be done with a deliberate commitment to emotional and intellectual safety in the classroom (very important). And as one of my mentors warned, it is the hardest thing we'll do trying to get into the minds of the students in this way. So far I have put six years into developing these skills, and I can say it is still worth the effort.

Last spring I was out for a few weeks with a health problem and was trying to guide my sub and classes through the curriculum from a distance. Part way through my convalescence, a colleague related a conversation she had with one of my students that succinctly summed up feedback I was beginning to get from other students. When my colleague asked the student how physics was going with the sub, she answered "OK, but when we ask him a question, he answers us, and we don't learn as much."

Question their answers. They learn more.