How To Build a Better Mousetrap: Changing the Way Science Is Taught through Constructivism

When I was a child, my favorite book was 101 Things To Do on a Rainy Day. The resource was full of all kinds of neat suggestions of games and activities that house-bound kids could do when the weather turned nasty. Through easy-to-follow pictures and brief, clearly written descriptions the book showed one how to make such things as rubber band-propelled boats and live-in villages with blanket-covered card tables. I can remember consulting pages in that manual into my adolescent years even after the book's binding had given up holding the pages in place.

As I think back on those days, I'm struck at how dependent I was on 101 Things To Do on a Rainy Day to get me through stormy days. It was a "cookbook" of fun activities. All I had to do was follow the directions and pictures in the text to end up with a new invention, the reward of my effort. Oh, I'm sure some kids discovered different ways of working with the activities than those suggested, and some may even have found new rewards by inventing thing that were not in the text after being primed by the "cookbook" descriptions. But most kids just had fun with the activities as they were described in the 315 pages of the manual.

I still have that rainy day resource book. It's stuck away in a molding box full of ancient papers and texts in my attic or corner of my office at the college. I had just begun to search my bookshelves when a student appeared at the open door to my office. She had missed the last few of my science classes of the semester and wanted to know the page numbers in her text that corresponded with the material covered in the classes. I asked her if she wanted to go over the material, but she didn't think she needed to because the textbook was full of charts, pictures and clear descriptions of the content I present in class. She was sure she could get the information she needed from the book. I pulled the text from the shelf next to my desk, thumbed to the table of contents in the front, and told her the chapters and page numbers we had covered while she was absent. She thanked me for my help and left to join her two friends waiting for her in the hall.

I sat there for a minute or two thinking about what the student had said. Could she really get everything she needed to know directly out of the text? Don't I play a larger role in a student's learning than disseminating information that can just as easily be gotten from the textbook? I look through the brightly colored pages of the resource with its slick graphics and splendid photographs. It was all the there! All Of the content a student needed to know to be rewarded with a passing grade in my course. All I did in class was to present the same content in the manual using overheads and an occasional slide or two. I was just an extension of the textbook itself. Amazed, I found myself looking at a science version of my childhood book, 101 Things To Do on a Rainy Day.

With this came the realization that the instructional method most often employed by professors to teach science in today's colleges and universities is the same as the one I used with my rainy-day source book. For many of our courses, all a student needs to do is to recite the directions in the text or lecture on a test to end up with the reward of passing our courses. Shouldn't professors excite students to think beyond the descriptions in their texts? Shouldn't we encourage students to look critically at the content or extend their thinking to other activities? Are we stressing the facts in the course so much that students are missing the overall picture?

I think one of the biggest fallacies in education today is the belief that content recitation and regurgitation confirms content comprehension and understanding. If a student writes a paper on the course material and passes a few tests about the subject, we reward the student with a passing grade for our course. The remarkable thing is that dozens of studies have found that most college students retain grand misconceptions and limited understanding about the subject after they have successfully passed the course, sometimes with an A+ (Kyle & Shyrnansky, 1989; Perkins, 19C3; Lorsbach, Tobin, Briscoe, & LaMaster, 1995).

In an attempt to explain why this is occurring, educational theorists have turned their attention to how a person actually gains new knowledge. This initiative has led many academics to question the behaviorist concept of learning, the "tried and true" philosophy of education that for decades formed the backbone of science instruction at all levels.

The behavioral model of science education holds that the teacher's job is to present stimuli and reinforcements that require students to respond in specific ways. For years, people viewed science as a means of finding truth, and truth was based on the factual content in journals and books. Because of this, students were taught to view science objectively rather than with imagination and understanding. As a result, teachers planned science lessons based on the facts they found in textbooks and other resources and evaluated students on their ability to recount the information. When the evaluation of student knowledge is based on rote memorization and reiteration of content, most students do quite well. If it is the objective of science teaching to have students replicate information, then the behavioral belief of teaching works beautifully. If, however, the goal of science teaching is to develop students who understand what the factual content is actually about and are able to apply this new knowledge to other situations, then the behavioral model of teaching fails miserably (Yaser, 1991).

Realizing that the old teaching methods are not producing true understanding, educators are beginning to examine what is really involved in achieving knowledge. This has led to the understanding that knowledge isn't something that lies outside one's body. Rather, conceptualization resides within a person. True knowledge isn't gained by students passively reading paragraphs in a text, looking at charts and pictures, watching videos or television, or hearing information recited by presenters. Students must actively pursue thinking. To acquire new knowledge, they must expend energy to allow the new information to interact with already perceived notions.

If one accepts this notion of knowledge acquisition, he or she will appreciate the learning philosophy called constructivism. Constructivists believe that the learner uses mental energy to construct new knowledge on the foundations of prior intellect (Glasersfeld, 1989).

Once students properly assimilate new knowledge, they reach real understanding of the issues. When this occurs, the enlightened person can easily explain what he or she has learned to others. In fact, verbal and written exchanges with colleagues are important in learning. By attempting to explain what one knows about a subject to someone else, the explainer tests the fit of his or her understanding of the material (Lorsbach & Tobin, 1993). Similarly, while tying to understand what someone is saying, active listeners question and challenge their own understanding and try to fit the information onto their already established cognitive foundations.

Constructivists believe that in the acquisition of knowledge, mental energies are expended by both the deliverer and the receiver. In a traditional, teacher directed classroom, mental energy is generally expended by the teacher (the deliverer) for the entire lesson. However, the expenditure of cognitive energy by the student (the receiver) that enables him or her to build the new knowledge on the old foundations rarely exceeds 10 to 12 straight minutes.

In a constructivist-based, student-centered classroom, the students' cognitive energy continues to take place for most of the class period. The teacher's mental energy also remains high throughout the lesson as he or she moves about assisting groups of students in their attempt to construct new knowledge. This conceptually directed vitality in students leads to higher interest and enthusiasm for the discipline. The increased student fascination for the subject reinforces the instructor's efforts and leads to more productive and enjoyable teaching. The end result is a wholesome learning environment that promotes curiosity, critical thinking, and lasting retention of knowledge.

LITERATURE CITED

Glasersfeld, E. von (1989). Cognition, construction of knowledge, and teaching. Synthese, 80, 121-140.

Kyle W. & J. Shymansky. (1989). Enhancing learning through conceptual change teaching. NARST News, 31(3): 7-8.

Lorsbach, A. & K. Tobin. (1993). Constructivism as a referent for science teaching, NARST News, 34(3) 9-11.

Lorsbach, A., K. Tobin, C. Briscoe, & S LaMaster. (1995). An interpretation of assessment method in middle school science, International Journal of Science Education, in press.

Perkins, D. (1993). Teaching for understanding, The American Educator, 17(3):2835.

Yager R. (1991). The constructivist learning model: toward real reform in science education. The Science Teacher, 53-57, September.

AUTHOR: Thomas R. Lord .
THOMAS R. LORD, a professor in the Department of Biology at Indiana University of Pennsylvania, received his bachelor and doctoral degrees from Rutgers University and his master's from the College of New Jersey. He has taught undergraduate science and science education majors for 30 years and has been an active contributor to his discipline through professional presentations and publications.

SOURCE: Contemporary Education 69 no3 134-6 Spr '98