Teaching for the Future

Teaching tips give preservice teachers a head start

HANS O. ANDERSEN

PREPARING STUDENTS TO TEACH science has been my profession since 1966, but my own preparation for this role began much earlier. In 1958, as a junior in college, I spent a lot of time thinking about what I wanted to do with my life. I loved people and science and, after reading the book *Science in a Tavern* (Schlicter, 1958), I knew I wanted a career involving both. Most of the book dealt with the early days of modern science when the Royal Academy held its meetings in taverns and discussions about science raged into the night. One chapter was different from the others in that it did not address science—it addressed teaching. Reading and rereading this chapter convinced me that "teaching is more than an art to be practiced, it is a life to be lived" (Schlicter, 1958, 184).

TEACHING EMERGING SUPERSTARS

Schlicter, who was a college freshman algebra teacher for most of his career, made other statements that defined a career path I have tried to follow in my own teaching. For example, Schlicter was shocked to learn that some people felt that teaching freshmen was a less important job than teaching more advanced students. He did not feel that he taught freshmen at all; he taught attorneys, bankers, entrepreneurs, physicians, surgeons, judges, members of Congress, governors, writers, editors, poets, inventors, great engineers, corporate presidents, railroad presidents, scientists, professors, deans, regents, and university presidents—all of the professionals those freshmen became (Schlicter, 1958, 177).

Like Schlicter, I have tried to convince other teachers that we do not ever just teach freshmen; we teach students who are in the process of emerging as leaders of our society. This is why teaching is so purposeful, why it is a life to be lived, why it is a process of evolving to meet the challenges faced by emerging youth. Perhaps Jocelyn Elders, the former surgeon general, stated it best when she said, "Children may only be 10 percent of our population, but they are 100 percent of our future" (1990). These words of wisdom are among the first I communicate to my preservice teachers, my "freshmen," who happen to be college seniors and beginning graduate students.

SECRETS OF GREAT TEACHERS

The second message I want to communicate to my students is the need to exhibit a positive attitude on the first and every day of teaching. Good teachers radiate an "of course you are going to learn" aura that reaches every student in their classes. Admittedly, we frequently have difficulty getting our students to learn in the time and sequence we have planned; however, we have never stopped children from learning. When leading the curriculum reform of the 1960s, Jerrold Zacharias stated, "If children could not understand something we were trying to teach, we assumed that it was we who were not clever enough, not the children" (Dow, 1991, 255). Teachers who feel students are not learning enough or fast enough should stop and ask themselves, "Am I being clever enough? Is there another approach that may be more effective?"

I also give students tips about good planning. I often hear about teachers who teach "off the cuff" with seemingly little planning. But good teachers rarely *stop* planning. Good teachers constantly search for new and better ideas whether traveling on vacation, watching a favorite TV presentation, listening to a spouse, or explor-

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ing the world with children. Planning almost becomes an obsession, a constant search for new approaches to old lessons, because variety can determine how, when, and how much their students will learn. Good teachers know that, "to be maximally effective, the lesson must stir the heart as well as the head" (Dow, 1991, 97).

One of the most important reasons for planning is to design a sequence of questions that leads students along a path to success. Questions can be the lubricant that allows the lesson to flow, the students to become engaged, and the learning to continue.

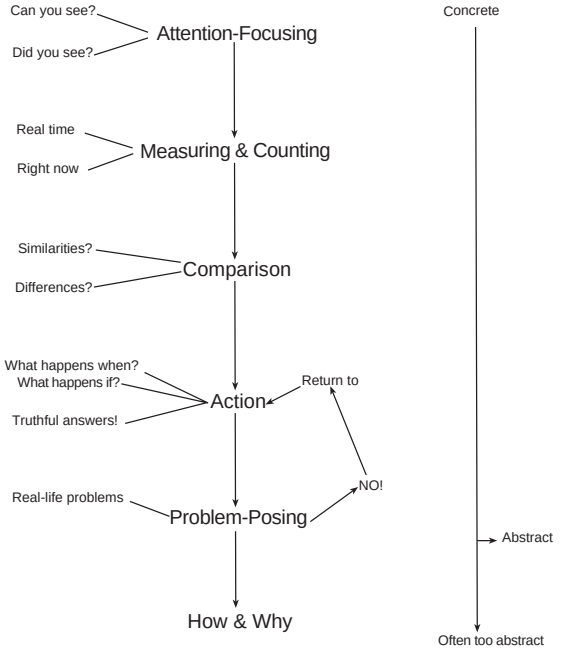
Lesson questions should proceed from concrete to abstract. One error made by many teachers, particularly beginning ones, is starting a lesson with an abstraction that confuses students. When faced with an abstraction first, many students simply conclude that they are not going to learn the material and stop trying. A carefully managed questioning sequence, on the other hand, facilitates student learning (Eltsgeest, 1985).

A QUESTION OF SEQUENCE

"A good question is a stimulating question which is an invitation to a closer look, a new experiment or a fresh exercise. The right question leads to where the answer can be found: to the real objects or events under study" (Eltsgeest, 1985, 37). The right question asks students to show rather than say the answer. Properly phrased questions stimulate productive student activity. There are many different kinds of questions ranging from concrete to abstract that can guide and direct students (Figure 1).

FIGURE 1.

A questioning sequence that can guide students.



Source: *Primary Science: Taking the Plunge;* Heinemann Educational Publishers, 1985.

Attention-focusing questions guide the necessary initial exploration of new materials, the "messing about" and getting-to-know-you stage of exploration. Look here! What is it? What does it show about itself? What happens? What do you see, feel, or hear? What can you tell me about this? Have you seen one of these before?

By contrast, measuring and counting questions direct students to do some real-time measuring and counting. Students must check their answers themselves. How many? How long? What is its mass? Comparison questions are those that bring about sharper observation by asking students to compare one object, event, or situation to another object, event, or situation. How are your seeds alike and how are they different? How are spiders like insects? What is the difference between an oak and a maple tree?

Action questions ask "What happens if . . .?" and can be answered by simple experiments. These questions are most appropriate at the beginning of experimentation because they direct students to explore the properties of unfamiliar materials, forces at work, and small events taking place. Examples of action questions include: What happens when you put NaCl in water? What happens if you don't put the ends of plants you cut into water?

The last kind of questions are problem-posing or "Can you find a way to . . . ?" questions. This type of question always sets up a real problem-solving situation. If a student responds negatively to a problem-posing question, it was probably asked too early in the questioning sequence. Problem-posing questions are essentially prediction questions that can be answered by forming hypotheses and conducting experiments. To successfully respond to this type of question, the student needs to identify and control variables; this is the point at which the student is really beginning to do science. Problem-posing questions are those like: Can you identify the sources of pollution of this lake? Can you identify the organisms that come to this bush for lunch? Can you make an egg container that would keep an egg intact even after falling 6 meters?

In contrast to all of these question types, how-and-why questions are often not useful because too many questions have not been answered. These questions often cannot be answered by students at anything other than the recall level.

According to this model, productive questioning begins with something very concrete and proceeds systematically and sometimes very slowly toward the abstract. Productive questioning might begin with the teacher pointing at something and saying, "What can you tell me about this?" Next the students are directed to take actual measurements and then compare their findings with other things they have already learned. Attention-focusing, measuring and counting, and comparison ques-

tions are all lesson-initiating devices that should be used in sequence as students review and reconstruct their knowledge base. Some students, particularly secondary science majors, argue that these questions are too easy to ask their students because their students already know all the answers. Do they? Teachers should ask and find out! They may be surprised. Other teachers claim that they do not have time to spend on these simple questions—they, too, are fooling themselves.

New teachers often want to know how many of each of these types of questions to ask. The answer is simple; teachers need to ask as many questions as necessary for students to be able to answer the next question. Skilled teachers who are working with successful upper-level students may spend minimal time on lesson-initiating questions; but these teachers are the first to emphasize the importance of these questions. Proceeding from concrete to abstract works because it engages more students in learning.

Teachers need to establish a system in which students think that they can be winners. One way to do so is to involve students in preparing rubrics that define what winning means. Students can be told exactly what will be on a test without actually telling them what will be on their test. That is, teachers could tell students what the topic of the test is and that the test will consist of 15 knowledge-level, 10 comprehension-level, 5 application-level, and 1 synthesis-level question. Students could also help construct a rubric to specify the number of each type of questions that, if successfully completed, would demonstrate that they had mastered the material.

All students can learn, but they have to do it for themselves. Sometimes they fail to learn for absolutely trivial reasons, reasons that the teacher should identify. The teacher's job, as facilitator, is to listen to students and eliminate these trivial reasons for not learning. For example, students may ponder over a complex, seemingly unsolvable problem because they cannot recall one trivial but important fact, only to recall that fact immediately after they turn in their test. What they know will determine what they will learn. Second, one must remember that we (including students) are all involved in constructing structures that contain our beliefs. Some of these structures become rigid misconceptions and seem immune to change. However, change is possible.

In closing, as a challenge to new teachers, I remind them of the three Ps of successful teaching—purpose, practice, and pride (Christensen, 1977). Students need a "real" purpose, and enough practice to do it well, so they develop pride in what they are doing. It is our job as teachers to make sure that students achieve these goals. ✧

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