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## THE EFFECTIVE SCIENCE TEACHER: WHO ARE YOU?

As a [science] teacher, you will have a special role in bridging the gap between the different world of science and scientists and the world of students in elementary, middle/junior, and high schools. Are there characteristics common to teachers who do this effectively? There are two sources of information that will help us with this question. One is the result of the effective teaching research over the past twenty-five years, and the other comes from the insight and wisdom if-you-will of outstanding secondary teachers.

### Effective Teachers

In recent years, researchers have investigated the relationship between teacher behavior (strategies and methods of instruction) and student performance (conceptual learning, attitudes). Through a technique in which a large number of research studies are synthesized, researchers have found clusters of instructional strategies and methods that are related to increased cognitive outcomes. At this stage in your study of science teaching, I assume that you have not mastered these behaviors. Instead, these characteristics will be viewed as advance organizers for our study of effective science teaching. The lists (Figures 1.19 and 1.19a) that follow have been paraphrased from Hofwolt and Borich.

Individual teachers will vary considerably in their style, and in the specific strategies they use to help students come to enjoy and learn science. However, there appears to be a clustering of broad patterns of teacher behaviors that effective teachers employ. Here are two sets of behaviors, shown side-by-side, one that appears to characterize secondary teachers in general, and the other that is more specific to secondary science teachers.

### Effective Teachers: What Strategies Do They Use?

- **Clarity:** Their presentation to the class is clear and understandable. Initial explanations are clear, logical and easy to follow.
- **Variety:** Teachers who show variety use a variety of behaviors to reinforce students, ask many and a variety of questions, use a variety of learning materials, equipment, displays---in short, hands-on materials.
- **Task Orientation:** Teachers who spend more time on intellectual content rather than on procedures or classroom rules tend to have higher rates of achievement.
- **On-Task Behavior:** This refers to the amount of time that students are actually on-tasks engaged with learning materials and activities. On-task behavior is closely related to classroom management behaviors of the teacher.
- **Success Rate:** This characteristic is closely related to student self-esteem. Naturally, if students are succeeding at moderate-to-high rates, then students are going to feel good about themselves as science learners and have positive attitudes about science. A key behavior here is the teachers ability to design learning tasks that lead to high success rates, but are not dull or repetitive, or viewed as a waste of time
- **Using Student Ideas:** acknowledging, modifying, applying, comparing, and summarizing student's comments can contribute to a positive learning environment. Teachers who use student ideas are genuinely interacting with students, thereby effecting student self-esteem.

- **Instructional Set:** This refers to teacher statements made at the beginning of a lesson, or at transition points in the lesson that help the students organize what is to come or what has happened before.
- **Questioning:** Teachers can and do ask a variety of questions. Knowing what kinds and when to ask questions seems to be important to student learning. Related to questioning is the behavior of 'wait time' which refers to the amount of time teachers wait after asking students a question
- **Enthusiasm:** This humanistic behavior refers to the teacher's vigor, power, involvement, excitement, and interest during a class presentation. Enthusiasm manifests itself by the teachers use of eye contact, gesturing, movement, use of supportive and approval behaviors, variety of teaching techniques, and love of science

### **An Effective Teacher Speaks**

There are many effective teachers in the United States. You will read in the Science Teachers Talk sections in the *Science Teacher Gazette* the comments made by several outstanding science teachers that I interviewed for this book. An eloquent spokesperson of effective teachers is Eliot Wigginton, one of the best-known high school teachers. Wigginton, who is a secondary teacher in Rabun County, Georgia, is probably best known for his *Foxfire books*, and community-based, experiential approach to teaching. In his book, Sometimes A Shining Moment: The Foxfire Experience---Twenty Years Teaching in a High School Classroom, Wigginton grapples with the question, How do we make teaching work? His response was to outline "some overarching truths" about teaching, principles of teaching which to Wigginton differentiate effective from ineffective teachers. Following are brief comments about each of these overarch truths. Wigginton acknowledges that he is constantly searching for ways to answer the question, and says that he tries new approaches, rips apart his lesson plans, and hopes for those moments when things work and his students soar. Examine his list, and compare them to the categories of behaviors that researchers have found to characterize effective teachers. Here in brief are Wigginton's overarching truths about teaching.

**Wholistic View of Subject Matter.** This is the characteristic that tends to get students to recall their memorable teachers. "They made the subject come alive," or "She really loved her subject," are some of things students remember about outstanding teachers. Wigginton claims that effective teachers see the interdependence of their own discipline with all others. They see their subject whole. They are the science teachers who see instantly every major science related news event. Or as he says, carpet dyes and gymnasium floor waxes and cans of beer become subjects of chemical analysis, and the first spring flowers become targets of botanical scrutiny. These teachers help students relate their subject matter to the whole world, and he goes as far to say that if there is no way to help students make linkages between this course and the whole world, and relate them to the students' lives, then the course should not be offered at all.

**Know How Learning Takes Place.** According to Wigginton, the effective teacher understands how learning takes place, knows how to apply the principles of learning, and believes that all students can learn. To Wigginton, this last notion is at the heart of the teaching profession. Teachers who know how learning takes place understand motivation in learning. They have moved away from extrinsic motives (candy, grades, a prize) toward intrinsic motives (natural curiosity, desire for competence and mastery). They help students make connections between the information they are to learn and their own world. These teachers also know that learning takes place by doing, and that learning begins with meaningful experiences and then moves to the text or the teacher, and then on to evaluation, analysis, reflection, and a return to meaningful, hands-on experiences.

**Know Their Students.** Wigginton feels that effective teachers try to bring education and the lives of students together by getting to know them better. He points out that is a tricky area, because many teachers feel distance should be kept from students---and perhaps students may not want to know us. However, Wigginton believes that in order to make instruction and the curriculum relevant to the students, it goes without saying, that educators must know their students. He says, for example, "when I know students reasonably well, I know the extent of the demands I can make upon them; I know something about their talents and abilities and likes and dislike, and thus I can lead them into educational activities with reasonable hope of success."

**Make Careful Assumptions.** The central idea here is very simple: the best teachers never make negative assumptions about the potential of their students. Wigginton says that too often, the disease model of education is at play, wherein the student is viewed as defective, and it is the job of schools and teachers to fix them. This is in stark contrast to his view that students have a variety of strengths and abilities, and it the the job of the school and teachers to take advantage of them, and in the process turn areas of weakness around. As Wigginton says, we make cripples of students on the basis of assumptions we make about them. As a future science teacher, this is especially crucial given the negative attitudes that prevail among students toward science. The evidence from research studies (especially the famous Pygmalion effect study by Robert Rosenthal) suggests that students who receive attention, have higher goals set for them, and even more demands, often do advance academically. Students who we establish low expectations for, give less attention, do not advance academically. Teachers' attitudes and the assumptions they make about students can play as important a role in cognitive learning as all the methods, strategies and materials of teaching that we use.

**Understand the Role of Self-esteem.** Effective teachers know that how students feel about themselves foretells how they perceive, react to, and perform in the world. Self-esteem is especially important in science teaching, again, because of the negative connotations students have toward the study of science. One of the best remedies, and effective teachers know this, is to plan learning experiences that lead to student success, that build upon the student's dignity and self-worth.

Wigginton explores other characteristics of effective teachers. He suggests that these teachers also recognize their humanness, understand the nature of discipline and control, help students analyze and react to other adults, constantly engage in professional growth activities, and know how to avoid teacher burnout.

As you continue with your study of science teaching, come back to these characteristics---those resulting from the science of research, and the wisdom-of-practice.