Teachers and Students: Constructivists Forging New Connections

As constructivists, teachers strike the delicate balance between teaching for fact and skill acquisition and teaching for independent and expert thinking.

There are two apparently opposing traditions in education, each with histories thousands of years long, each with distinct goals and practices, and each with passionate advocates who still fight with one another. Jackson (1986) characterizes these traditions as (1) the *mimetic*, in which students are expected to acquire facts and skills from drill and practice exercises, and (2) the *transformative*, a type of teaching that seeks to influence the attitudes and interests of the learners, evoking changes in perspective. In the mimetic tradition, teachers disseminate knowledge, and students receive it. In the transformative, the student is the actor, and the teacher is the mediator.

I suspect that this dichotomy, which characterizes the current debate on teaching, is a mistaken conception. The key principle is to balance the extremes. Alone, either extreme is insufficient preparation for a world that demands specific knowledge and skills, but also attitudes and interests conducive to vision and creativity. To use a computer to solve complex problems creatively, for example, we must first load the software in precise accordance with the manufacturer's instructions. To decide whether to wrap a potato for baking with the shiny side of the aluminum foil in or out, we need to know some specifics about thermal absorption and radiation. Both instances require information *and* intellect, fact *and* interpretation.

The primary question for the teacher, therefore, is how to help students build a foundation of skills and information while they simultaneously use their creative, intellectual abilities to solve real problems and incidentally develop positive dispositions toward such endeavors. The powerful concept of *constructivism* can help us find solutions to this question.[1] By taking a constructivist approach, educators can avoid the either/or syndrome and balance the two traditions.

Individual Constructions of Reality

Constructivists believe that knowledge is the result of individual constructions of reality. From their perspective, learning occurs through the continual creation of rules and hypotheses to explain what is observed. The need to create new rules and formulate new hypotheses occurs when the student's present conceptions of reality are thrown out of balance by disparities between those conceptions and new observations.

Constructivism *doesn't* say, as some claim, that you can't teach people anything. It guides us in finding out *how* to teach them.

Constructivism describes an internal psychological process. In the classroom, students and teachers negotiate both their means of acquiring credibility as members of a group and their emerging understanding of the content of the curriculum. These negotiations occur as each participant actively seeks to learn about himself or herself, the other group members, and the content of the course.

In this process, each person is continuously checking new information against old rules, revising the rules when discrepancies appear, and reaching new understandings, or constructions of reality. In psychological terms, the old rules are the existing cognitive structures. When the old rules and the new information collide, the checking process generates cognitive disequilibrium. The revision is the accommodation that occurs when new rules or new internal cognitive struc-

tures are required to replace the old ones, which no longer explain reality. The new understandings are stops along the path of learning that occur when equilibrium is temporarily restored. This process occurs in both the teachers and the students, in both academic and social contexts.

Teaching as Research

Nevertheless, *constructivism* is not a euphemism for "anything goes." Learning content and skills is still the educational goal. But "the critical feature is *how* the knowledge is acquired," as Sigel reminds us (1978, p. 333). Students must develop the necessary content-bound understandings without sacrificing the intellectual autonomy essential for the construction of meaning.

A teacher's daily challenge, then, is to transform ideas into action. The ideas often come from the district's philosophy statement, grade level or curriculum guidelines, teachers' manuals, the principal's yearly charge to the staff, and one's own vision. The transformations of these ideas into classroom practice are highly personalized endeavors. To make these transformations ably and with insight requires content area knowledge, communication skills, and a vision of what intellectual autonomy in a developing thinker looks and feels like. Thus, the teacher's personal pedagogy is critical to the education of students as developing thinkers.

Sigel (1978) asserts our need to understand the role of social interactions in how teachers come to construe the practice of teaching. If teachers are to set up classrooms where inquiry is encouraged, then they must be educated in ways that encourage inquiry. The willingness and the competence of the teacher to seek and find meaning through direct experience and reflection influences how she or he will structure and mediate that learning environment.

Our abilities to foster student inquiry and research are enhanced by the degree to which we envision it—and to the degree that we ourselves inquire and research. The teacher's role, then, is twofold. First, teachers must continue to develop knowledge

The intellectual opportunities the teacher offers the students are carefully constructed invitations that maximize the *possibility* that new conceptual learning will occur.

of content—of genetics, numeration, or political conflicts, as examples. Second, at the same time, teachers must continually analyze and reconstruct ideas of pedagogy—knowledge of how to teach these subjects.

Indeed, Duckworth (1987) observes that teachers are in a position to pursue questions about the development of understanding that no one else could pursue in the same way. She goes on to describe teaching as *research*.

> This kind of researcher would be a teacher in the sense of caring about some part of the world and how it works enough to want to make it accessible to others: he or she would be fascinated by the questions of how to engage people in it and how people make sense of it . . . (p. 140).

What Constructivist Classes Look Like

The traditional way of structuring lessons is concept introduction, practice, application, and further exploration, if time allows. But models of learning based on constructivist principles most often suggest a sequence of lessons in which exploration comes first. The Learning Cycle Model (Atkin and Karplus 1962) of exploration-invention-discovery, which has a long history in the field of science teaching, is an example of constructivist-based education. Using this model, a teacher designs opportunities for students to experience the lesson concepts through direct encounters with materials or information (the exploration stage). The teacher next formally introduces the concept to be considered, usually using new terms and introducing new information and different ways of thinking (the invention stage). Finally, the teacher provides further activities that involve the same concepts (the discovery stage). The purpose of this sequence is to give students of subjects other than science the opportunity to express their points of views and grapple with important issues in the topic. This creates the intellectually fertile basis for the introduction of a new concept. Teachers are now using this model where they once used more mimetic plans; for example, to teach students to use library resources, to develop physical education skills, and to play musical instruments (Kaplan et al. 1989).

Teachers in Shoreham-Wading River School District generated the descriptors of constructivist teaching practices listed in the sidebar as part of a large-scale inservice education and research project. The project, originally called the Cognitive Levels Matching Project, is now known as the Child Developmental Study Seminar Series. The list is an evolving document that represents the most widely used practices of teachers who describe themselves as constructivists.

I would now like to highlight four critical dimensions of a constructivist classroom. One feature of constructivist-based education is the structuring of curriculum around primary concepts: the teacher enters the classroom with one or two big ideas, not with a long list of stepping-stone skills and objectives. For an entire academic year, for instance, students in a 6th grade mathematics class studied ratios and proportions. The lessons were designed to develop students' proportional reasoning abilities. The objectives were explored—not "covered"—in the natural and spontaneous context of students' thinking. While comparing the radii of circles given the circumferences, for example, students *asked* for a review lesson on the division of decimals. They had come to the mature conclusion that

to solve a real problem, they needed an arithmetic skill. They demonstrated, incidentally, that when students solve real problems, their thinking recapitulates the development of "expert" thought. Through inquiry into important concepts, the class achieves the objectives listed in the text or curriculum guidelines, and in a deeper, more memorable way.

Two additional related dimensions of a constructivist program are the uncovering of alternative conceptions—or "misconceptions"—and the attempt to understand the learner's point of view. *Misconceptions* refer to the theories students have generated to explain various phenomena, behaviors, interactions—theories that are wrong from the adult perspective. Although their thinking may be wonderful, it may be based on faulty assumptions, lack of information, or incorrect data. And, as most teachers know, the rendering of "correct" explanations does not necessarily change the child's misconception.

The teaching of a concept, therefore, is not effective unless the child's present understanding of the concept is explicitly explored. The students must confront any inconsistency between their notions and the data in front of them before they can entertain the teacher's ideas. Thus, the task of the teacher, after coming to understand the nature of the students' present notions, is to structure a classroom in which students experience disequilibrium and, subsequently, self-regulation.

Again, remember that constructivism refers to an internal psychological process. The teacher cannot demand that a student see an inconsistency and accommodate his or her thinking by developing a new mental scheme. Rather, the teacher offers intellectual opportunities carefully constructed as invitations that maximize the *possibility* that new conceptual learning will occur.

Constructivist Teaching Practices

1. Encourage and accept student autonomy, initiation, and leadership.
2. Whenever possible, use raw data and primary sources, along with manipulative, interactive, and physical materials.
3. When framing tasks, use cognitive terminology like *classify, analyze, predict,* and so on.
4. Allow student thinking to drive lessons. Shift instructional strategies or alter content based on student responses.
5. Ask students for their theories about concepts before sharing your understandings of those concepts.
6. Encourage students to engage in dialogue, both with the teacher and with one another.
7. Seek elaboration of students' initial responses.
8. Pose contradictions to students' initial hypotheses and then encourage a response. (This process requires considerable diplomacy—an idea must be contradicted without attacking an individual's whole perspective.)
9. Encourage student inquiry by asking thoughtful, open-ended questions and encouraging students to ask questions of others.
10. Allow wait-time after posing questions.
11. Provide time for students to discover relationships and create metaphors.
12. Encourage students to reflect on experiences and actions and then predict future outcomes.
13. When designing curriculum, organize information around conceptual clusters—of problems, questions, discrepant situations.
14. Both before and during class, adapt curriculums so that their cognitive demands match the cognitive schemes of students.
15. Look for students' alternative conceptions, and design subsequent lessons to address any misconceptions.
16. For selected tasks, group students according to their demonstrated cognitive complexity.

Another aspect of constructivism has to do with conflict. Within a context of growth and cooperation, conflict is the source of developmental progress. It is not the teacher's intent to structure a classroom in which conflict is avoided. Rather, it is the teacher's job to help students negotiate the frictions that inevitably arise in settings that provoke them to challenge ideas, most often their own.

Reinventing the Wheel

Although constructivism as a guiding principle in education is receiving more attention today than in the past, much confusion persists over its message and its implications. Suppes (1989), a critic of what he calls the romanticism of this approach, asks, "What are you going to do, rediscover the wheel?" (p. 909). The answer is "yes." In the ideal educational setting, students will rediscover the wheel, reinvent long division, rediscover the horrors of war, and reinvent government.

For an example of the usefulness of reinventing the wheel, consider this instance. Sixth graders were trying to determine whether there was any relationship between the radius of a circle and its circumference. After experimenting with construction paper, some string, a ruler, and a pencil, one student said: "I think I've come up with something. If you take the number around a circle and divide it by the line going across, no matter how big the circle is, you always get about 3!" The child, approximating the value of π, had seen it as a ratio of two other features of a circle. Who do you think will be more likely to understand and remember the meaning of π—a child introduced to the concept as an element in a formula or this discovering child?

Constructivism *doesn't* say, as critics claim, that you can't teach people anything; it guides us in finding out *how* to teach them. Constructivism reminds us that order exists only in the minds of people, so when we as teachers impose our order on students, we rob them of the opportunity to create knowledge and understanding themselves. Our task, then, is to understand and nurture the learning and development of our

students. We must not do for them what they can, and must, do for themselves.□

[1]The work of Jean Piaget, the most renowned proponent of constructivist theory, has formed the basis of countless early childhood programs (Copple et al. 1979, Kamii 1974), many tests of intellectual development (Lawson 1978, Arlin 1984), innumerable research designs (Linn et al. 1977, Groen 1978), and, more recently, investigations of constructivist approaches in educational programs for adolescents and adults (Lampert 1984, Narode and Lochhead 1985). Over the last few years, other educators have paid some attention to constructivism in the process of education (Copple et al. 1979, Labinowicz 1985, Blais 1988).

References

Arlin, P. (1984). *Arlin Test of Formal Reasoning*. East Aurora, N.Y.: Slosson Educational Publications.

Atkin, J.M., and R. Karplus. (1962). "Discovery or Invention?" *Science Teacher* 29, 5.

Blais, D. (1988). "Constructivism—A Theoretical Revolution for Algebra." *Mathematics Teacher*.

Copple, C., I. Sigel, and R. Saunders. (1979). *Educating the Young Thinker*. New York: D. Van Nostrand.

Duckworth, E. (1987). *The Having of Wonderful Ideas and Other Essays on Teaching and Learning*. New York: Teachers College Press.

Groen, G. (1978). "The Theoretical Ideas of Piaget and Educational Practice." In *Impact of Research on Education: Some Case Studies*. National Academy of Education.

Jackson, P. (1986). *The Practice of Teaching*. New York: Teachers College Press.

Kamii, C. (1974). "The Aim of Education Envisioned by Piaget." *Phi Delta Kappan* 65.

Kaplan, R., D. Lutjen, and I. Platt. (August 1989). Personal communication, Shoreham, New York.

Labinowicz, E. (1985). *Learning from Children*. Menlo Park, Calif.: Addison-Wesley.

Lampert, M. (1984). "Thinking About Teaching and Teaching about Thinking." *Journal of Curriculum Studies* 16.

Lawson, A.E. (1978). "The Development and Validation of a Classroom Test of Formal Reasoning." *Journal of Research on Science Teaching* 15.

Linn, M., B. Chen, and H. Thier. (1977). "Teaching Children to Control Variables: Investigation of a Free Choice Environment." *Journal of Research on Science Teaching* 14.

Narode, R., and J. Lochhead. (1985). "What Do You Think?" *IMPACT on Instructional Improvement* 19, 3: 56–62.

Sigel, I. (1978). "Constructivism and Teacher Education." *The Elementary School Journal* 78, 5.

Suppes, P., cited in Holden, C. (1989). "News and Comment." *Science* 244: 906–909.

Jacqueline Grennon Brooks is Assistant Professor of Education, Teachers College, Columbia University, New York, N.Y., and was formerly a teacher in Shoreham-Wading River School District, Shoreham, New York. She can be reached at 15 Dogwood Rd., Stony Brook, NY 11790.