LEARNING

HENRY J. PERKINSON* ## *FROM OUR MISTAKES*

M Y THESIS IS THAT THE LEADING EDUCATIONAL THEORISTS of the
twentieth century have shared a common theory. The theorists I
have in mind include John Dewey, Maria Montessori, A. S. Neill, Jean
Piaget, Carl Rogers, and B. F. Skinner. And the theory they share,
simply stated, is, "We learn from our mistakes."

Pre-Twentieth Century Educational Theory

The theory that reigned in educational thought from the 17th to the
20th century—and still continues to hold considerable sway over
educational practice today—construes education as a process of
transmission. It was probably best expressed by Comenius in *The
Great Didactic* when he said that education is like printing. "Instead
of paper," Comenius wrote, "we have pupils whose minds have to be
imprinted with the symbols of knowledge." He then goes on: ". . . the
ink is replaced by the voice of the master since it is this that conveys in-
formation to the minds of the listeners; while the press is school
discipline, which keeps the pupils up to their work and compels them
to learn." An even more famous metaphor for the transmission theory
of education is John Locke's *tabula rasa*, according to which the
student's mind is a blank sheet of paper ready to have knowledge in-
scribed upon it by the teacher. As a variant metaphor, Locke also con-
strued the student as a ball of wax which the teacher may shape and
form as he pleases. We still find this transmission theory of education
usually postulated in discussions about "getting the material across to

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the students," and in promises to "promote learning," or worries about "effecting change" in students.

The most salient feature of the transmission theory is its conception of the role of the teacher, for here the teacher is the cause of the student's learning: the teacher transmits knowledge to the student. Related to this is the conception of the student as a passive receptor of knowledge who often needs to be controlled, or motivated, so that he will readily receive what the teacher transmits.

Historically, Rousseau was one of the first to criticize the transmission theory of education. He rejected it on moral grounds. The theory, he said, makes education an authoritarian activity wherein the teacher "shapes" the student "to his master's taste like the trees in his garden."

Rousseau proposed that we construe education as an organic process of growth rather than as a mechanical process like printing. But his notions of how growth occurs won him few followers. Rousseau proposed that growth was simply the spontaneous unfolding of what already existed *in* the child at birth. This flew in the face of the common sense of most people largely because it didn't square with the widely accepted transmission theory. So, before they could accept the notion of education as growth, it had to be brought into accord with the transmission theory. John Dewey did this. And yet, although Dewey did continue to promulgate a version of the transmission theory of education, his work opened the way for the emergence of the new, 20th century educational theory.

It was the 19th century ideas about biological evolution that made it possible for Dewey to convert the notion of education as a process of growth into a version of the transmission theory of education. According to the 19th century biologists, evolution or growth is a matter of adaptation to the environment. Through the many different adaptations over time that organisms have made to the ever-changing environmental conditions, whole new species have evolved. According to one theory, postulated by Lamarck, organisms that acquired new characteristics through adaptation to the environment then transmitted these characteristics to their offspring. In this way, biological changes were perpetuated. For example, Lamarck would have us believe that the long neck of the giraffe evolved when some of the animals grew long necks in order to secure food—because all the leaves on the lower branches of the trees were gone. Then, those giraffes who had grown long necks transmitted this acquired characteristic to their offspring. In time all giraffes—the story goes—had long necks.

Dewey, following Lamarck, construed educational growth as a process of adaptation to the environment. Children, he explained, learn

or acquire behavior (adaptive behavior) when they are confronted with problems—just like the giraffes who grew long necks when they had a problem.

Learning or growth, then, begins with problems. But growth itself consists of new behavior, new skills, new knowledge that solves the problem at hand, that secures adaptation to the environment. Dewey noted that the human race had already acquired solutions to many of the problems of survival—problems of securing food, clothing, shelter, problems of communication and transportation, for example. The work of education was to transmit to the young those behaviors and skills that had worked for the species in the past, behaviors known to be adapted to the environment. Dewey expected school teachers to concoct problems that students found meaningful and which, at the same time, led them to acquire or discover the useful knowledge already possessed by the human race.

Now Dewey, of course, realized that in an ever-changing world, the specific behaviors acquired would in time become obsolete. The ways we now secure food, clothing, shelter, for example, may, in the future, simply not work. So, to prepare people to live in an ever-changing world, we must, Dewey argued, teach them *how* to learn. If they learn how to learn, then they can always solve new problems of adaptation as those problems arise; they can always discover the new behaviors necessary; they can always grow.

Learning how to learn, for Dewey, meant learning how to solve problems of adaptation. And here Dewey went beyond the ideas of Lamarck, for he believed that human beings had developed *the* method for solving problems of adaptation—the scientific method. Dewey regarded the scientific method as the noblest achievement of mankind: it was through the scientific method that western man had acquired knowledge and improved the human condition, and it was through the scientific method that we could insure the continued growth of our civilization. Armed with the scientific method, human beings could become problem solvers far superior to all other organisms—for all other organisms had to rely on the method of trial and error—a method he viewed as blind and wasteful. Whereas if we transmit the scientific method to the young, then, Dewey promised, the prospect for future individual and societal growth would be glorious.

Today we realize that Lamarck's ideas about evolution are false. The giraffe's long neck did not come about because some giraffes transmitted the long necks they had acquired through deliberate attempts to solve the problem of securing food. We know that acquired characteristics are not biologically transmitted.

Charles Darwin had a better explanation. According to Darwin, the giraffe's long neck is the result of blind trials and natural selection. That is, some giraffes were born with long necks. They survived; the others did not. As Darwin explains it, the evolution of the long neck of the giraffe is the result of natural selection—or to put it another way, the result of the natural elimination of the unfit.

The most salient feature of Darwin's theory of evolution is the complete absence of any transmission of acquired characteristics. Evolution takes place because organisms give birth to offspring that are similar, but not identical, replicas of themselves. However, the environment then eliminates those offspring that are not adequate. So, given the procreation of offspring, growth or evolution takes place in a negative way. We might say that it occurs through the elimination of errors.

It is a short step from Darwin's theory of evolution to what I have called the 20th century theory of education—the theory that we learn from our mistakes. Let me quickly sketch the basic features of this theory.

Human beings do not only conceive and give birth to offspring; they also create knowledge—theories, beliefs, ideas, skills. But this knowledge is never perfect. It is always limited in some way, or inadequate, or mistaken. Therefore, this knowledge can always be improved, always grow. It grows or evolves in a Darwinian fashion; that is, through the elimination of whatever is unfit. Just as the species evolved through trial and error elimination, so with knowledge. We make conjectures or try out our theories and ideas, and then improve them by eliminating the mistakes and errors they contain. In short, we learn from our mistakes.

The initial step in learning from our mistakes is recognizing that our present knowledge is inadequate. And although Dewey followed Lamarck rather than Darwin, he nevertheless can lay claim to the title of Father of Twentieth-Century Educational Theory insofar as he insisted that all growth or learning begins with a problem. For, awareness of a problem is a recognition that one's present knowledge is mistaken. A problem exists because the organism's theory, conduct, or understanding, is wrong or inadequate. If our knowledge were perfect, nothing unexpected could ever happen; no problems could arise for us.

In accordance with the theory that we learn from our mistakes, Dewey assigned the teacher the task of introducing students to problems—which I interpret as the task of making them aware of their errors and mistakes. But as a transitional figure who still accepted the transmission theory of education, Dewey also thought that teachers

could transmit to students the solutions to those problems, or at least, transmit the method for solving problems.

The Darwinian approach to education denies that human beings have any such wisdom to transmit, and it asserts that we have no need of such wisdom since growth occurs without transmission. Indeed, the notion that knowledge can be, or ever is, transmitted, is as much a myth as the Lamarckian notion that acquired characteristics can be, or ever are, biologically transmitted.

The other leading educational theorists of the 20th century have elaborated this Darwinian construction of education, a construction I have called the theory that "we learn from our mistakes." How then do we learn from our mistakes?

How We Learn From Our Mistakes

Here is how Piaget explains it. Piaget has established conclusively what many people have always suspected; namely, that a child does not understand the world in the way an adult does. Yet, the child is not in a state of continual confusion. The world does make sense to the child—or better: the child does make sense *of* the world. At each stage of its cognitive development, the child has what Piaget calls cognitive structures through which it understands the world. For reasons I will explain later, I will call these cognitive structures "theories."

Here is an example of how cognitive structures, or theories, function:

As we all know, an infant loses interest in objects when they are out of sight. Piaget noted this in his own infant daughter. Then he came up with a brilliant insight: when the object is out of sight, then, for the infant, the object no longer exists. The cognitive structures of the infant, Piaget says, do not include "perceptual constancy." The fact that objects are continually passing out of existence and then back into existence does not upset the infant. It makes sense. In fact, it delights infants, as witness the game of peek-a-boo where, for the infant, an adult repeatedly vanishes and reappears. My interpretation of the absence of perceptual constancy is that the infant has a theory, a basic or core theory—a metaphysical theory, if you will—about existence; to wit: to exist is *to be* perceived. This basic or core theory permits the infant to make its initial cognitive discoveries: its own self—its fingers, legs, all parts of its body; the existence of other selves, and other objects.

This theory of existence is, however, inadequate; indeed, it is false. And we find that, in time, the infant modifies, or changes, or refines it into a better theory—into the theory that most all of us have about ex-

istence: namely, to exist is to be *capable of* being perceived. Piaget reports that his daughter up until eight months of age lost interest in objects when they "vanished" — when, that is, Piaget covered them with a blanket. One of the objects Piaget experimented with was his own pocket watch. At about eight months of age, the infant began to reach under the blanket for the "vanished" watch. The child had begun to develop perceptual constancy. Or, in my language, the child had begun to replace a false theory of existence (to exist is to be perceived) with a better one (to exist is to be capable of being perceived.)

How did this happen? The answer, I suggest, is that the child learned from its mistakes.

Look at the pocket watch experiment again. Here we recognize that although hidden from the infant's sight, the watch still ticked, so the infant could hear it. Thus, the infant confronts a contradiction: the watch is out of sight, so according to the infant's primitive theory of existence, the watch does not exist; but the infant hears the watch, so it must exist.

One way to overcome contradictions is to deny them; to become dogmatic. This is what infants do, initially. So long as it does not recognize the contradictions inherent in the theory of existence, the infant continues to lose interest in objects hidden from view, continues to accept that those objects do not exist even though they do continually reappear, or regain existence. The infant "sees" no contradictions. Finally, however, the contradictions force themselves on him, or he becomes conscious of them. Once the contradictions become manifest, once the infant recognizes and accepts the presence of a contradiction, he tries to overcome it by modifying the old theory in order to eliminate the inadequacies he now recognizes inherent in it. This results in a new theory, a theory the child has created, a new theory that makes better sense of the world — a better theory like "to exist is to be capable of being perceived." As the child develops this new theory over time, he begins to look for balls and other objects that "vanish" under the blanket — objects that make no noise and are no longer visually perceptible, but which the child "knows" do exist because he now has a theory that "tells" him that the object could not have vanished — it is simply hidden from view.

What I have called experiencing a contradiction Piaget has called "disequilibrium," and what I have called creating a new theory he has called "accommodation." Disequilibrium (contradictions) leads us, he says, to accommodation (creating a new theory).

Terminology aside, I think it clear that Piaget has supplied us with an explanation of how we learn from our mistakes. The infant starts

out (he may be born with) metaphysical theories. I have used the example of "existence," but Piaget has also traced the development of other metaphysical theories like causality, time, space, etc. With all these, the child uses his original theory "to make sense of the world." But, in time, he begins to recognize contradictions to the theory which signal that the theory is false. The child has a problem, as Dewey would put it. Or, in Piaget's words, he experiences disequilibrium. To overcome the contradictions, to solve the problem, to restore equilibrium, the child creates (literally *creates* — although not out of nothing, but rather by modifying the old theory) a new theory, a better core theory, or better basic theory through which he continues to make sense of the world. In Piaget's language, the child accommodates to the world.

In his analysis of the later stages of cognitive development, Piaget further elaborates how we learn from our mistakes. During what Piaget calls the pre-operational stage, which usually begins around two years of age and lasts until about seven, the child develops the ability to speak. Speech enormously increases his capacity for making generalities or theories about the world he lives in. He creates various sounds and tries them out. Through trial-and-error elimination — i.e., through making mistakes and then eliminating them — he learns that the sound "ball" is the label for a ball; that "hat" is the label for hat, and so on. During this stage, then, the basic or metaphysical theory of concern to the child is the theory of identity: is *this* the same as (or different from) *that*? And during this period, the child initially creates over-generalized theories of identity so that he calls all dogs "Spot" for example, or gives the same label to a coat, a jacket, or shirt. In time, however, he modifies his original trials, eliminating the errors and begins to use language more or less as it is used in his environment.

What is happening here is that the child is creating theories of identity — theories that he uses to try to make sense of his world, theories that he tries out, discovers are inadequate, and then modifies and tries out again. Thus, the child often becomes frightened and confused the first time he sees his grandmother wearing a hat. His theory of identity is one of *complete* identity. To him, the person with the hat is not his grandmother. The most dramatic and widely-known example of this pre-operational theory of identity is Piaget's famous water-in-the-glass experiment. Here, the water from a short, squat glass is poured into a much taller and much thinner glass. When asked, the pre-operational child says that the tall, thin glass contains more water — even though he watched the experimenter pour the water into it from the other glass. The child will actually argue and become quite dogmatic about his claim that the thin glass contains

more water. His argument is based on his theory of identity. For *this* water to be the same as *that* water, the water level must be the same. (If the experimenter pours the water from the tall, thin glass back into the short, squat glass, the pre-operational child will say that the short glass contains less water than was in the tall one.) As a variation on this experiment, Piaget used lumps of clay. Pre-operational children claimed that there was more clay when it was pounded into a round ball than there was when it was stretched out into a long, thin loaf.

Not until he is about seven years of age does the child recognize that the claim that the tall, thin glass contains more water contradicts the claim that it is the same water that was in the short, squat glass. When he recognizes this contradiction, he begins to create a new theory of identity, a theory that will encompass inverse relationships. Henceforth, he will recognize that the amount of water or the amount of clay is identical in each case, for he knows, although he may not be able to articulate it, that the rise in the water in the tall glass is inversely related to the diminution in diameter.

I make note in passing that Piaget calls this phenomenon "conservation." His interpretation of the experiment is that the child has not yet created the cognitive structures that enable him to perceive that matter is conserved — that attributes of an object are constant even though it changes appearance. My interpretation makes it a matter of the theory of identity that the pre-operational child uses to make sense of the world. I use the term theory rather than cognitive structure or concept because theories, unlike concepts and structures, are true or false. And we learn from our mistakes by discovering in what ways our theories are false and then trying to eliminate that falsity.

As the child gets older, the matter of truth and falsity becomes more complex. Indeed, in the third and fourth stages of development — what Piaget calls the operational stage, the core theory of most concern is the theory of truth: how do we distinguish truth from falsity? Or better: how can we select (reject) false theories and false statements?

During the earlier pre-operational period the child had a primitive theory of truth — the "mommy says" theory of truth. The child had unquestioningly accepted his parents, his teachers, and perhaps most adults as the external authority for truth and falsity and accepted them as the agents of selection; that is, if the parent or teacher said that this object is called a "bali" and that is called a "hat" then this *is* a ball, and that *is* a hat. Even in the matter of the water in the glass experiment, the child will accept as true what the parent says about the water being equal — the child just cannot understand *why* it is so, or why adults say it is so. Now, in Piaget's third and fourth stages of cognitive development, the child begins to create a logical theory of

truth, and this means that he now possesses an internal selector that he can use to identify and reject false claims.

In the third stage of cognitive development—what Piaget calls concrete-operational—the focus is on theories of logical relationship, including the logic of classes. Here, for the first time, the child is able to use logical relationships to make sense of the world—but only if he is confronted with concrete objects and is allowed to perform concrete logical operations with them.

During this concrete operational stage, the child has a kind of naive empirical theory of truth. He knows that there is an order in the universe, but he can only test or check his theories about that order through some kind of a concrete operation—by looking at things, or counting them, or manipulating them.

At the next, and last stage of formal or logical operations, the child recognizes that every proposition has a contradiction, every proposition has correlations and implications. He refuses to accept propositions, or claims, or rules, that are not logical. When they reach the formal operational stage, people continue to learn from their mistakes but they now possess a powerful agent for uncovering and eliminating errors: formal logic. As always, they try to understand or make sense of the world by creating theories, or making conjectures to interpret or decode whatever they encounter. But now they use logic to monitor these theories and conjectures. When their conjectured understanding of a claim, a proposition, a statement, contradicts—directly or by implication—some knowledge they already have, then they reject the proposed claim or statement if it does not logically cohere with their existing logically coherent knowledge. Moreover, they can now make arguments against the proposed claim or statement. But they can understand counter-arguments, too. And when these counter-arguments reveal to them that this argument or their knowledge is mistaken, then they modify their original knowledge. From this point on, all future cognitive growth results from logical argument, for logic becomes the tool for discovering our mistakes.

In explaining how we learn from our mistakes, Piaget has elaborated a conception of the learner that is diametrically opposed to the conception contained in the transmission theory of education. According to that theory, you will remember, the learner is a passive receptor of knowledge who must often be controlled or motivated to pay attention. But with Piaget, we realize that human beings are active, not passive learners.

In addition to construing the learner as active, Piaget has identified a second characteristic of learners that all the 20th century educational theorists share: the learner is a creator of knowledge. Human beings are not blank sheets of paper awaiting the imprinting of

knowledge, nor are they like buckets waiting to be filled up with knowledge. They are not receivers of knowledge; they are creators of knowledge.(1)

Finally, in addition to construing the learner as an active creator of knowledge, Piaget has explained that the spring of learning is not the desire for rewards and fear of punishment — as the transmission theory would have it — but simply the learner's quest for order. Human beings do not have to be motivated to learn, nor do they have to be controlled. Human beings learn because they seek order; they try to make sense of things. Another way to put this is to say that human beings try to eliminate contradictions.

Ultimately then, the explanation of how we learn from our mistakes consists of a conception of human beings as active creators of knowledge who seek order. But why, one can ask, do human beings seek such order? And here, strangely enough, we find an answer in the work of B.F. Skinner.

In turning to the theories of Skinner, it is necessary to note right off that Skinner is different from all other 20th century educational theorists I have mentioned. Unlike them, he accepts the transmission theory of education. In fact, he is probably the most astute transmission theorist ever.

Yet, having said this, I note that one of the most interesting aspects of Skinner's behaviorism is his attempt to construe it as part of Darwinian natural selection. Here's how he does it. According to Skinner, the environment selects, thus preserves, some behavior and rejects other behavior. That which is selected *is* so selected, he says, for its survival value. This selection takes place through reinforcement: some behavior is reinforced and thus survives — or better: such behavior is more likely to occur again. Reinforcement strengthens behavior.

What Skinner has done is to reject all antecedent "inner" causes of behavior. We do not act because we have a "purpose," a "need," or a "drive." The consequences or contingencies of behavior are its cause. That is, to explain why John did this and not that, we have to examine his history, or biography. For John did this rather than that, Skinner says, because the environment had so conditioned him. First of all, the environment conditioned him genetically. That is, the environment acted on his ancestors by selecting only those behaviors that contributed to, or had the consequence of, survival. So John did this rather than that because of his genetic conditioning. But in addition, John has his own history of operant conditioning. That is, some of his past behavior had consequences that reinforced him during his life. These contingencies of reinforcement result in the operant conditioning which, together with his genetic conditioning, supply the complete explanation of why John did this rather than that.

Skinner's theory about how learning takes place is easily translatable into the theory, "we learn from our mistakes." We can use the term "trials" to describe the various behaviors that organisms emit on those occasions when they confront a problem of some kind, and organisms confront problems continuously. Remember too that a problem consists of a lack, an inadequacy, a mistake in the organism—in its theories or its conduct, or its understanding of its situation. The new behavior that the organism then emits to solve the problem is also usually inadequate, or lacking, or mistaken in some way; it too, contains errors. When the organism recognizes these errors, it tries to eliminate them in the next trial. Skinner explains this "error elimination" phenomenon by saying that the erroneous behavior was not reinforced, hence, not likely to be repeated. He credits the error elimination to the environment. I credit it to the organism. As I see it, the organism modifies its own conduct in light of its recognized errors. But why?

Using Skinner's terminology, one can say that mistakes, and errors, are *aversive* to all human beings. They are what he calls "negative reinforcers." Whenever an organism encounters a negative reinforcer—an electric shock, say, or hunger—it acts to try to avoid, escape, or overcome that aversive situation. I suggest that a mistake or an error constitutes a contradiction to one or more of the organism's theories. That theory produced certain expectations. The expectations were unfulfilled. The outcome contradicted the expectations. Here then is an explanation of why human beings seek order, or try to avoid contradictions. Human beings do this because contradictions are aversive to them. And this aversion is the result of contingencies of survival: those organisms that did not seek to overcome contradictions, or establish order, or eliminate errors, did not survive. The organisms that have survived are those that have trial-and-error elimination as part of their genetically inherited repertoire of behavior.

Skinner, of course, talks about positive reinforcement as well as negative reinforcement. In fact, he prefers that teachers use positive reinforcement in controlling and modifying the behavior of students. I want to argue that positive reinforcement does not exist. The distinction Skinner makes between positive and negative reinforcement is a purely verbal one. There is only negative reinforcement, i.e., aversive situations, including contradictions, which organisms try to eliminate or abate.

What Skinner calls positive reinforcement is simply negative reinforcement occurring in a highly controlled environment. In this highly controlled environment, the organism encounters an aversive stimulus, and all attempts to escape or overcome the aversion are

unsuccessful—except for a specific (kind of) behavior, a behavior predetermined by the controller as the "correct" behavior. Thus, a pigeon who is hungry (an aversive situation) makes many moves (trials); but in a highly controlled Skinner box, the pigeon fails to overcome this aversive situation until it makes the (kind of) move the experimenter wants it to make; e.g., pecking at a red disk. At this point, it gets a pellet of food. Skinner calls this positive reinforcement, but it is obvious that what we have here can be described as a case of negative reinforcement in a totally controlled environment where all possible trials, except for one (kind), are going to be unsuccessful. In this controlled environment, the pigeon construes each unsuccessful trial as a mistake, an error, and so tries again. The trial that works— the trial that overcomes the aversion—is strengthened and becomes part of the bird's repertoire. A pigeon, all organisms, build up their repertoire through learning from their mistakes. And the repertoire itself consists of behavior for overcoming mistakes, eliminating errors—avoiding aversive situations.

At this point, we might ask why Skinner *favors* what he calls "positive reinforcement." The answer, I think, lies in his acceptance of a Lamarckian theory of cultural growth. Skinner is quite frank in his espousal of Lamarckianism. Here's what he wrote in *Beyond Freedom and Dignity:* "Cultural evolution is Lamarckian in the sense that acquired practices are transmitted." (p. 124) So, Skinner favors positive reinforcement because he construes growth as a Lamarckian process of transmission: the adult generation transmits the culture it has acquired to the next generation and Skinner recognizes that such a process of transmission takes place with facility when the learner is highly controlled.

I have argued that the control Skinner insists upon is necessary because learning is a procedure wherein an organism tries to eliminate or avoid an aversive situation. So, if a teacher wants to "transmit" something to a student, it becomes necessary to create an aversive situation and to control the student's situation in order to make sure that the only behavior of the student that will overcome the aversive situation is that which the teacher has already predetermined as the "correct" behavior.

If this argument is correct, then transmission is a myth. No one transmits knowledge, or ideas, or behavior, or anything, to a learner. The teacher "presents" material to students. Now this may look as though a teacher is transmitting, but this is an illusion. What actually happens is that by "presenting" this material the teacher creates an aversive situation—a situation such that the learner recognizes or becomes aware that his own present knowledge or behavior is inadequate or mistaken. To overcome this inadequacy or eliminate his

mistake, the learner modifies his present knowledge or present behavior. But the teacher at the same time *controls* the environment to such an extent that no behavior the learner emits will overcome that aversive situation except that which the teacher has predetermined to be the correct behavior. So, what looks like transmission is actually a matter of learning from our mistakes.

If these arguments are correct, then, once again, we conclude that in all cases we learn from our mistakes. The learner is always learning from his mistakes. He is continually engaged in trial and error elimination. This is a Darwinian notion of learning as growth.

How then can teachers help students grow?

The Role of the Teacher

The theory that "we learn from our mistakes" leads teachers to make three assumptions about their students: first, the teacher assumes that the student has knowledge; second, the teacher assumes that that knowledge is inadequate or limited, or false; third, the teacher assumes that the student will refine or modify that knowledge upon becoming aware of its inadequacies. The role of the teacher, then, is to create an educative environment—an environment that reveals to the student the inadequacy of his present knowledge. In Dewey's terminology, the teacher raises problems for the student.

In concert with the three assumptions about students, an educative environment has three characteristics: it is free, it is responsive, and it is supportive. By a free environment, I mean one wherein the student feels free to reveal or make public his or her present knowledge. In a free environment, no one is punished or threatened because of mistakes. Indeed, a free classroom is a place wherein one makes mistakes—that is what classrooms are for.

But in order to learn from our mistakes, we have to recognize them. And this is why the teacher creates not only a free environment, but one that is responsive as well. A responsive environment provides feedback to students—critical feedback that tells them what is wrong, inadequate, or limited in their present knowledge.

Since, however, such critical feedback is usually disconcerting and upsetting to most students, the teacher must also, at the same time, create an environment that is supportive. The students must feel that the teacher cares for them, trusts them, perhaps even loves them. In a supportive environment, students do not feel put down by critical feedback, for the supportive teacher encourages the student to try again, to refine or modify his present knowledge—to improve.

Maria Montessori clearly explains how the teacher creates an educative environment. In the Montessori classroom she envisioned,

the teacher does not transmit knowledge. Montessori calls the teacher a "directress." She directs learning by creating a free, responsive, and supportive environment wherein the students can learn from their mistakes.

The most noteworthy feature of the Montessori classroom are the so-called didactic materials. I interpret them as providing an educative environment. They invite the student to make public, or elicit from him, his present knowledge, his present skills. In playing with these materials, the child freely reveals his present sensory and motor skills. These didactic materials are also responsive: they provide critical feedback to the student, helping him to recognize the inadequacies and limitations of his present skills. If the student's ability to discriminate colors, weights, dimensions, and so on, is inadequate, the didactic materials designed for each skill will reveal this to him. The student, for example, will have a dowel that will not fit into the last remaining hole in the peg board. This reveals to the student that his ability to discriminate dimensions needs improvement.

Moreover, this didactic material reveals the student's errors in a non-threatening way. Nor does the Montessori teacher chastise, punish, or pressure students. She supports and cares for them. Each student, therefore, receives encouragement—from the non-threatening materials and from the supportive teacher—to try again, to refine or modify what he did before, to eliminate his mistakes. And the child continues this procedure of trial and error elimination over and over until his knowledge or skill reaches the level required by the didactic material he is playing with.

In addition to the didactic materials, the Montessori classroom uses games and imitation in various practical activities, like gardening—all to create educative environments wherein children can learn from their mistakes. In all these activities the task of the teacher is the same: to create a free, responsive, supportive environment—where the students will freely reveal their present knowledge, get critical feedback and try again.

To facilitate learning from mistakes, Montessori warned teachers to take into consideration the maturation of the child. By this, she meant what Piaget has also stressed: until they develop basic or core theories (cognitive structures) children cannot recognize their mistakes as mistakes. The Montessori teacher does not correct, does not judge. All education is self-education; or, as she called it, auto-education. This means that the student must himself recognize his mistakes and eliminate them. The teacher merely creates the environment wherein the student freely, when he is ready, focusses on one specific skill, or kind of knowledge, at a time in order to improve it.

Montessori has cast the teacher into a role diametrically opposed to those teachers who believe it their task to transmit knowledge to students. Of course, teachers who try to function as transmitters create classroom environments too—usually *un*free, *un*responsive, and *non*-supportive environments. Anxious to tell students what they *should* know and do, would-be transmitters often never find out what students actually *do* know and *can* do. Necessarily, then, would-be transmitters do not construct a responsive environment that elicits the student's present knowledge—except for purposes of evaluation and grading. But then the environment becomes scary and threatening to students—not supportive. So, when teachers set out to transmit knowledge they create environments that do not facilitate learning from one's mistakes.

Yet, you may say, students *do* learn in transmitter classrooms, in classrooms that are not free, responsive, and supportive. How come?

My explanation is that in all cases students learn from their mistakes. The would-be transmitter is, as I said, creating an environment for the students. What the teacher presents to the students, the subject matter, the instruction, is the central part of that environment.

The transmitter teacher presents the subject matter as something true or correct—something the student must accept and later demonstrate more or less mastery of. Given this situation, the student uses his interpretation of what has been presented as the means for recognizing the inadequacies in his present knowledge and then he modifies that present knowledge in light of what the teacher presented.

So, learning does occur in classrooms run by would-be transmitters, but here, as in all cases, it is a matter of learning from our mistakes. What is wrong with classrooms run by would-be transmitters is what people ever since Dewey have complained about: no real learning takes place in them, students simply acquire artificial "school knowledge," which is not meaningful to most of them. By this I mean that in so far as classrooms are *not* free, responsive, and supportive environments, students do not reveal, hence do not modify, the knowledge they commonly use to conduct themselves in the role of student. Such knowledge is often of little significance to them outside of school. It lacks meaning.

Creating a free, responsive, and supportive environment is a better guarantee that meaningful learning will take place. For in this kind of environment, the student is free to present or make public his present knowledge—whatever it is. His knowledge is taken seriously and responded to; not evaluated or judged, but examined and its inadequacies or limitations brought out. When this is done in a caring, sup-

portive environment, the student will be encouraged to modify what is meaningful to him: his own knowledge.

Another, common criticism of classrooms run by would-be transmitters is that such classrooms stymie or curtail continual growth in the knowledge of that subject matter. For in the environment of a transmitter classroom the stress is on what's right. Here the only mistake is to display knowledge different from that prescribed by the teacher. As a result, these classrooms foster dogmatic students, confident that they know the truth—i.e., what the teacher told them. This kind of confidence does not generate continued growth.

In a free, responsive, supportive classroom, however, students become risk takers; they become self-critical, and accustomed to modifying their knowledge in the light of recognized errors. They become confident of the possibility of improving their knowledge. This kind of confidence does generate continued growth.

This concern for facilitating meaningful learning and continual growth led Carl Rogers, another of the 20th century educational theorists, to abandon in toto the transmission theory of education. Like Montessori, he wants teachers to create educative environments—environments that facilitate learning. In a Rogerian classroom, students have freedom to learn—freedom to learn from their mistakes.

Rogers places great emphasis on the necessity of a supportive environment. The teacher, he says, should be prizing, accepting, and trusting. An empathetic, caring teacher, he explains, will elicit the student's present knowledge, skills, and dispositions. The teacher will find out where the student is. This is the first step in the facilitation of learning.

Rogers seems to place less emphasis upon having teachers create a responsive environment. This may be due to the fact that he came to education from the field of psychotherapy and so had less to do with curriculum and subject matter than other educational theorists. But a responsive educational environment (in contrast to a therapeutic environment) always consists of subject-matter content—whether in the form of skills or theories or conduct. So, even though Rogers himself does not emphasize the creation of a responsive classroom environment, the subject matter, the material presented in that environment does create a responsive environment—it helps the student discover the limitations and inadequacies of his present knowledge. And because, like the Montessori classroom, the Rogerian classroom is free and supportive, the student is encouraged to modify and refine his present knowledge by eliminating the errors in repeated trials.

This is a good place to say a few words about the nature of subject matter in 20th century educational theory.

Montessori, who spent most of her time working on the education of young children, focused understandably on the development of skills—especially sensory and motor skills. This included the teaching of reading, writing, and calculating. It is easy to see, I think, how the creation of a free, responsive, and supportive environment will facilitate the *improvement* of skills, since the learning of skills is always a matter of refining or modifying skills one already has.

It is also easy, I think, to see how the creation of such environments can facilitate the learning of other skills: athletic skills—like running, jumping, swimming; marketable skills—like typing, woodworking, sewing; and artistic skills—like painting, drawing, singing. With these and all skills—as most coaches, most art ed teachers and most vocational education teachers know—the teacher's task is to elicit the student's present skills, help him or her discover the limitations and inadequacies of those skills and then encourage the student to eliminate those inadequacies in successive trials.

In teaching skills, the teacher often demonstrates or presents an example for the student to imitate. This is a good way to elicit the students' present abilities and a way to help them to discover their specific mistakes. Imitation is a way of learning from our mistakes—a way of making trials and eliminating errors.

Carl Rogers, who has written more about the education of older students, indicates that the 20th century theory of learning from our mistakes applies to all subject matter, not just skills. Students learn from their mistakes in history, in science, in literature, for example. Here again, the basic assumption is that students already possess knowledge. Their historical knowledge, for example, or their scientific knowledge, may be very elemental and even unarticulated; nevertheless, all students will have some theories about the universe they live in, and some theories about the past.

Each student's knowledge is, of course, limited, and it is likely to be inaccurate. The teacher's task is to help him improve his existing knowledge. The first step is to make him aware of the inadequacies of his present knowledge. One way to do this is for the teacher to present to the student the theories or the work of professional historians or scientists—or works of literature, or philosophical theories, or some body of knowledge from whatever the subject matter happens to be.

The teacher presents the work not for the student to grasp and accept and remember—but rather, as something for the students to confront, to engage, to encounter. Once again, the role of the teacher is to create an educative environment: a free, responsive, supportive environment. Students feel free to criticize the work presented; this is how the students reveal their present knowledge. Then the teacher responds to their criticisms, presenting counter-criticisms. The

criticism from the teacher is in the invitational mode: it invites the student to engage in dialogue. The dialogue is between the student and the text. The teacher functions as the interlocutor—the teacher interprets the students and the text to one another and the teacher referees the dialogue to help the interaction between the student and text move along and be fair and honest.

So, in all subjects, we learn from our mistakes—through trial and error elimination. Whether it be skills, or theories, or conduct, teachers can facilitate learning or improvement through creating free, responsive, and supportive environments.

As to the improvement of conduct, let me remind you of the work of A.S. Neill at Summerhill. Neill, as I view him, constructed a school that was first and foremost an institution for moral and social education. Summerhill was an environment: a free, responsive, supportive environment.

I'm sure you will readily agree that Summerhill was free and supportive. "We set out," Neill said, "to make a school in which we should allow children to be themselves." Yet, although Summerhill was a free and supportive environment, it was not *totally* free or *continually* supportive. Summerhill was not a do-as-you-please place; it was a community, although to be sure, it was what might be called a minimal community. What made it a minimal community was the one basic inviolable rule: "Each individual is free to do what he likes as long as he is not trespassing on the freedom of others."

This rule creates a responsive environment—a responsible environment composed of "significant others." For whenever someone—be he fellow student, teacher, headmaster, or cook—acts in a way that adversely affects someone else, then that someone responds by complaining, criticizing, or in some way letting the offender know that his action has hurt another. Actions that hurt another are wrong, or inadequate, or bad. So since the subject matter or the curriculum was social and moral conduct, at Summerhill the responsive environment consisted of other people. And when an offender was criticized, he could "take" his criticism because he lived in a free, supportive environment. He knew that he was free and that no adult was going to censure or punish him: he knew he was loved and supported. When someone criticized a specific action of his, he realized that the critic was not condemning him as a person, but only his conduct. The critic simply wanted him to stop, or to change what he was doing.

In this kind of an environment, children became what Neill called "self-regulating." The child was subject to no authority telling him what to do, or what not to do. But as a member of the Summerhill community, he learned to modify or change his behavior when it adversely affected others. For in the responsive environment of

Summerhill, one always discovered the consequences of one's actions when they did, in fact, adversely affect others.

So, without any ostensible moral instruction, without any moralizing, students became moral, social beings. They learned how to behave through making mistakes—through trial and error elimination. One of the important features of Summerhill was the weekly school meeting. "In my opinion," Neill wrote, "one weekly General School Meeting is of more value than a week's curriculum of school subjects." The agenda of these meetings were concrete issues that explored the significance and wider application of this minimal community rule. ("Each individual is free to do what he likes as long as he is not trespassing on the freedom of others.") By dealing with the concrete issues of human conduct that arose each week, the community learned how to apply the basic rule, how to interpret it, how to formulate and how to amend specific extensions of the rule. The community learned how to be self-regulating and it learned this by making mistakes, as a community. At one weekly meeting, a new regulation would be proposed, discussed, and passed. In time, all would come to recognize that it was in some way inadequate. So, in time, at another general meeting, the community would modify, change, or repeal the regulation. Just as individuals did, the community grew or improved through trial and error elimination.

We are now at a point to tackle the most common criticism made of Summerhill—Summerhill, the critics say, did not prepare the young to live in the larger society; Summerhill was an island.

It is important to note that this criticism is based upon a transmission theory of social education. That is, it assumes that social education is a process of imposing accepted habits or patterns of conduct. But Neill had an entirely different theory of social education. Neill's theory of social education was not one of transmission. It was the 20th century theory that we learn from our mistakes. And what students learned at Summerhill was social and moral sensitivity.

This social and moral sensitivity is largely a matter of being self-critical. Summerhill students came to accept their human fallibility. They came to recognize that they sometimes acted in ways (not usually by design) that hurt others. Having accepted this, Summerhill students came to look for the consequences of their actions that did adversely affect others, and they became open to critical feedback from others about their actions. As a result, Summerhill students were self-regulating—they modified or changed their conduct in the light of its unwanted and unexpected consequences.

So moral and social education at Summerhill did not consist (as socialization does) of the transmission of a pre-determined set of behavior or habits. It was the development of a moral and social sen-

sitivity which allowed the Summerhill graduates to live in any com-
munity or any society or any social group. The graduate can do this
because he or she is self-critical. And the reports that have come in
about Summerhill graduates confirm this — they have no trouble living
in the real world — they continually learn from their mistakes.

Summary

I have argued that these 20th century educational theorists share a
common theory — that of "learning from our mistakes." According to
this theory, human beings are active creators who seek order. They
create knowledge — which includes theories, skills and conduct. But
because human beings are not perfect creators, but rather fallible
creators, the knowledge that they create is inadequate or limited, or
mistaken — it lacks order; the expectations our knowledge generates is
often contradicted by our experiences. Because of genetic endowment,
when human beings recognize these inadequacies they modify or
change their knowledge in order to eliminate the mistakes or limita-
tions. This improvement or advancement of knowledge is a procedure
of selection, or trial and error elimination. And since human beings
are fallible, further growth or improvement is always possible — it is
endless.

These 20th century educational theorists share a more or less com-
mon construction of the role of the teacher: the teacher facilitates
growth or improvement through the creation of free, responsive, sup-
portive environments. Such an environment evokes or elicits or pro-
vokes knowledge from the students, provides critical feedback to help
them recognize their errors, and gives them support sufficient to
encourage them to try again, to modify their knowledge in light of its
recognized errors. Through such educative environments, schools
become places for people to make mistakes — for that's how people
learn from their mistakes.

NOTES AND REFERENCES

1.   Here I must note that Piaget's own theory stops short of construing his learner as
      the creator of all his knowledge. According to Piaget — a zoologist turned
      psychologist — human beings grow via what he calls adaptation. Adaptation
      consists of two movements: accomodation and assimilation. The human being
      has cognitive structures with which he *assimilates* knowledge from the en-
      vironment. (Analogous to those physiological structures through which we
      assimilate vital nutrients from the environment.) But when the cognitive struc-

tures prove to be inadequate, which is recognized by the emergence of a condition of disequilibrium between the organism and the environment, then the learner *accommodates* by creating new cognitive structures.

Note that there is still a strong whiff of transmission theory here. To use the bucket metaphor: we might say that Piaget does construe the learner as a bucket to be filled with knowledge (assimilation), except that he also says that the learner makes and remakes (creates) the bucket (accommodation).

In so far as his theory is one of transmission, Piaget has a theory of learning that is more Lamarckian than Darwinian. In so far as his theory construes growth as a process of trial and error elimination, it is Darwinian. The theory of learning I elaborate in the text tries to eliminate all transmission and attempts to explain all learning via (Darwinian) selection—trial and error elimination.

This is another reason why I prefer to use the term theory, or basic core theory, instead of cognitive structure. My position is that *all* our knowledge is created; it all consists of theories we have developed or conjectured. Some of these theories are *core* theories within the constraints of which we create (we do not assimilate) all other theories about the universe. These core theories operate as agents of selection: they eliminate or reject any theory we create to "make sense" of any phenomena if that second theory contravenes a core theory. Thus, we do not accept a theory that says the coin vanished, that it went out of existence. We do not accept it because this theory contravenes our core or basic theory about existence. The sources for this Darwinian approach are Karl Popper (especially *Objective Knowledge*, 1972, and D. T. Campbell, "Evolutionary Epistemology," 1974).