

Piaget's Theory, Behaviorism, and Other Theories in Education

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The article places Piaget's theory in the context of other psychological and epistemological theories that have influenced education. With respect to the psychological aspect, it shows that the relationship between behaviorism and Piaget's theory is not a mutually exclusive one, but a part-whole relationship in which behaviorism is encompassed by Piaget's theory. With respect to the epistemological aspect, it shows that his constructivist interactionism is a synthesis that encompasses both empiricism and rationalism. Since education has been based mostly on empiricist assumptions, the conclusion reached is that Piaget's theory implies the need for a fundamental reconceptualization of curriculum and methods of teaching.

Education has been influenced by many theories or philosophies, such as those of Socrates, St. Augustine, Comenius, Rousseau, and Dewey. The term "theory" in this context refers broadly to "a particular conception or view of something to be done or of the method of doing it" (Barnhart, 1963). In recent years, educators have been influenced by different kinds of theories — namely, scientific theories, which have been tested and verified empirically all over the world. Examples of scientific theories are behaviorism and Piaget's theory.

Piaget's theory is very different from behaviorism, and the two are often discussed as if they were mutually exclusive, as shown in figure 1(a). An example of this view is as follows.

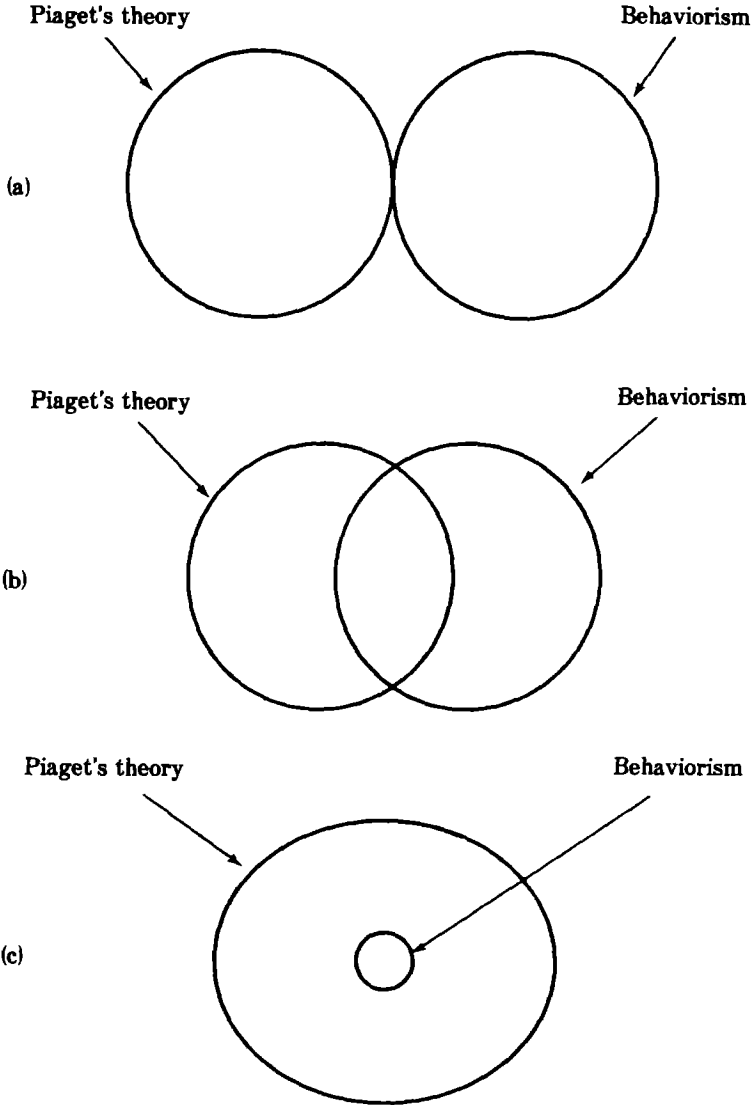
The cognitive-developmentalists, following Piagetian theory, believes that the process of education is one of building cognitive structures in the mind of the child. The behavior modifier, following the theories of B. F. Skinner, is wont to say that he does not know what cognitive structures are — that he believes these are fictions, myths, invented by the psychologist that serve more to hinder than to help his understanding of how the child learns. The Skinnerian conceives of education as a process of producing changes in observable behavior. . . . The Skinnerian thinks of behavior as being under stimulus control and holds that education consists of bringing specified behavior under the control of specified stimuli. . . . The Skinnerian does not, of course, believe that the child has no brain or that nothing goes on inside the head — only that it is not profitable to speculate about these internal processes, since they cannot be directly observed or controlled. . . .

The Piagetian does not conceive of the child as being under stimulus control. On the contrary, to put the issue in the most extreme form, he conceives of stimuli as

*This paper was written with the support of the Urban Education Research Program, College of Education, University of Illinois at Chicago Circle.

Figure 1

RELATIONSHIPS BETWEEN BEHAVIORISM
AND PIAGET'S THEORY



being under the control of the child. More stimuli are always present in the stimulus complex that surrounds the child than he can respond to. The child . . . not only selects, but interprets what is selected in terms of his previously stored experience. (Maccoby & Zellner, 1970, pp. 33-34)

This material can also be represented as shown in figure 1(b). The intersection in this figure stands for the statement that "the Skinnerian does not, of course, believe that the child has no brain or that nothing goes on inside the head."

How can two scientific theories be so opposed and yet true? In the discussion that follows, I will attempt to answer this question, discuss the epistemological significance of Piaget's theory, and present the educational implications of these theories.

Piaget's Theory and Behaviorism

The relationship between the two theories as I see it is represented in figure 1(c). As can be seen in this figure, behaviorism is much more limited than Piaget's theory and can, in fact, be encompassed by it. Piaget's theory is broader and more powerful than behaviorism because it can explain every intellectual and moral phenomenon described by behaviorism, while behaviorism cannot explain most of Piaget's findings. Let us take the example of Pavlov's dog, which is interpreted by behaviorists as demonstrating conditioning and extinction. Piaget's interpretation of the same phenomenon is different in that for him, after the repeated presentation of the bell and meat, the bell comes to be a signal for the appearance of food (Piaget, 1947, 1967; Piaget & Inhelder, 1966). If the meat subsequently stops appearing, the dog simply stops anticipating it. Piaget thus explains conditioning and extinction in terms of the organism's ability to attribute meaning to objects and events and to anticipate future happenings, thereby adapting to its environment.

While Piaget's theory can in this way explain the phenomena studied by behaviorists, the converse is not the case. Let us take as an example the quantification of class inclusion (Inhelder & Piaget, 1959). No behaviorist can explain why all children begin by saying that there are more dogs than animals. Neither can behaviorists explain why children, without any teaching whatsoever, later come to say that there are more animals than dogs.

In order to present Piaget's explanation of the quantification of class inclusion, it is necessary first to clarify the task. In this task, the child is given six miniature dogs and two cats of the same size, for example, and is asked, "What do you see?" so that the examiner can proceed with whatever word came from the child's vocabulary. The child is then asked to show "all the animals," "all the dogs," and "all the cats" with the words that come from his vocabulary (e.g., "doggy"). Only after ascertaining the child's under-

standing of these words does the adult ask the following class-inclusion question: "Are there more dogs or more animals?"

Four-year-olds typically answer, "More dogs," whereupon the adult asks, "Than what?" The 4-year-olds' answer is, "Than cats." In other words, the question the examiner asks is "Are there more dogs or more animals?" but the one young children "hear" is "Are there more dogs or more cats?" Young children hear a question that is different from the one the adult asked because once they have mentally cut the whole into two parts, the only thing they can think about is the two parts. For them, at that moment, the whole no longer exists. They can think about the whole, but not when they are thinking about the parts. In order to compare the whole with a part, the child has to do two opposite mental actions at the same time — cut the whole into two parts and put the parts back together into a whole. This, according to Piaget, is precisely what 4-year-olds cannot do.

By 8 years of age, Piaget states, most children's thought becomes mobile enough to be reversible. Reversibility refers to the ability to mentally do opposite actions simultaneously — in this case, to separate the whole into two parts and reunite the parts into a whole. In physical, material action, it is not possible to do two opposite things simultaneously. In our heads, however, this is possible, when thought has become mobile enough to be reversible. It is only when the parts can be reunited in the mind that a child can "see" that there are more animals than dogs.

Piaget thus explains the attainment of the hierarchical structure of class inclusion by the increasing mobility of children's thought, which culminates in reversibility. In the quantification of class inclusion, furthermore, there is no extinction. Once the child believes that there are more animals than dogs, there is no way of convincing him that he should go back to his earlier way of thinking. This is an example of a cognitive structure, alluded to earlier, and behaviorism is indeed too limited to explain how logic develops in the human mind.

Let us take another example, from the realm of moral development, to explain figure 1(c). In *The Moral Judgment of the Child*, Piaget (1932) spoke of sanctions, which the translator unfortunately changed to "punishment." In this book, Piaget stated that adults use sanctions to get children to behave in certain ways, and that in life it is often impossible to avoid sanctions (for example, when we don't want children to touch knobs on the television or stereo set). While he thus acknowledged the inevitability of sanctions (and in this sense agreed with behaviorists), he also insisted that they have the effect of prolonging the child's heteronomy by preventing the development of autonomy. Autonomy, it will be recalled, is a term that means "governing oneself." Heteronomy, by contrast, means "being governed by somebody else." Heteronomy can be seen in the example of the 7-year-old who says "no" to the question, "Would it be bad to tell lies if you

were not punished?" Autonomy, on the other hand, can be seen in the example of the 12-year-old who said, "Sometimes you almost have to tell lies to a grown-up, but it's rotten to do it to another fellow" (p. 173). Autonomous people have their own criteria for judging what is right or wrong, and their judgments are not based on whether or not they might be punished.

We can limit sanctions to the positive side and practice reward without punishment and approval rather than disapproval. However, all the power of positive sanctions can only result in prolonging the child's heteronomy. Sanctions explain why most people's behavior can be controlled to a large extent, but they cannot explain the courageous behavior of autonomous people who refuse to go along with the reward system and who stand up for what they believe to be morally right. Heteronomy can be explained by behaviorism, but autonomy can be explained only by a broader theory.¹

The relationship between behaviorism and Piaget's theory is analogous to that between the geocentric theory and the heliocentric theory in astronomy, between Newton's theory and Einstein's in physics, and between Euclidean geometry and non-Euclidean geometry. Many people today have trouble seeing the part-whole relationship shown in figure 1(c) because Piaget's theory is revolutionary, and the psychology of learning is in the midst of what Thomas Kuhn (1962) calls a scientific revolution. Kuhn points out that each scientific revolution grows out of the inadequacy of the previous theory. For example, the Copernican revolution came after a long period of dissatisfaction with the inaccuracies obtained in calculating the positions of planets and in trying to make the old calendar work within the geocentric theory. Astronomers kept making corrections for these inaccuracies, until the geocentric theory became hopelessly complex and incoherent. Just as astronomers introduced corrections in the geocentric theory to make calculations correspond to the actual positions of planets, behaviorists have introduced corrections which only complicate a model that is inadequate to begin with. Hull's (1952) "fractional antedating goal responses" is an example of such corrections.

What Copernicus did was to create a new conceptual framework through which he looked at the same planets, thereby increasing the accuracy, simplicity, and coherence of astronomy. The first reaction to any revolutionary theory, according to Kuhn, is resistance. Since all scientists are trained to think about and study nature in a way that fits the conceptual framework supplied by their education, it is natural for them to resist a new framework that subverts the old rules of how to go about trying to get at the truth. Copernicus was laughed off the stage by his fellow scholars, and the ridicule was so strong that for at least 16 years, Galileo felt the need to pretend that he disagreed with Copernicus (Koestler, 1959).

What happens after the initial resistance is competition between two groups — the one committed to the old framework and the one committed to

the new one. According to Kuhn, competition between segments of the scientific community is the only process that historically has resulted in the rejection of a previously accepted theory.

If there is a tendency today to view behaviorism and Piaget's theory as mutually exclusive, as shown in figure 1(a), or as only partially overlapping, as shown in figure 1(b), it is because we are in the midst of a revolution, when two segments of the scientific community are in competition. The mutually exclusive relationship implies that educators must choose one and reject the other. Figure 1(c) shows that Piaget's theory leads not to the rejection of behaviorism, but to its inclusion in a larger, more adequate theory. The pedagogical implication of figure 1(c) is that behaviorism can still be useful to solve certain problems within certain limits. For example, the logic of multiplication cannot be taught by programmed instruction, but once this logic is constructed by the child, memorization is the only way for him to learn the multiplication tables. Behaviorism can be useful within certain limits because immediate feedback is very useful in this kind of memorization. Spelling is another obvious example where behaviorism can be applied effectively.

The geocentric theory is likewise not entirely false or useless. Within a certain limited point of view, it is still adequate today, as can be seen in the terms "sunrise" and "sunset" which we hear in the daily weather forecast. Likewise, Newtonian physics and Euclidean geometry are still entirely adequate to solve most practical problems today. In all these scientific revolutions, the old theory became encompassed in a broader, more adequate theory. Just as Newtonian physics became a particular case of Einstein's theory, Euclidean geometry became a particular case of non-Euclidean geometry.

The evolution of a child's thought from one level to the next is similar to the evolution of scientific theories. For example, when the child becomes a conserver, he does not reject his previous way of thinking. He still thinks that the liquid in the taller, thinner glass is "more" in a certain sense, but he has a very different way of apprehending this "fact" when he can coordinate a host of relationships and assimilate the old fact into a new system of relationships. Just as preoperational relationships become incorporated into later relationships, behaviorism becomes incorporated into a more complete theory that eliminates the contradictions found in the previous theory.

The revolutionary nature of Piaget's theory has been discussed above to show that the adequacy of an educational program can be determined by the adequacy of the theory on which the program is based. To the extent that a theory is scientific, it can be subjected to the same scrutiny as any other scientific theory. I think, therefore, that the competition between behaviorism and Piaget's theory will eventually be resolved.² What worries me more is the fact that most educational practices are based not on tightly

conceptualized scientific theories, but on diffuse, implicit beliefs which are not subjected to rigorous examination. In order to discuss these diffuse beliefs, I would now like to shift from Piaget's theory as a psychological theory to the broader epistemological questions he addressed.

Empiricism, Rationalism, and Piaget's Theory

Piaget is often believed to be a psychologist, but he is actually an epistemologist. Epistemology is the study of the nature and origins of knowledge, expressed in such questions as How do we know what we think we know? and How do we know that what we think we know is true? Two main currents developed over the centuries in answer to these questions, the empiricist and the rationalist currents.

Empiricists (such as Locke, Berkeley, and Hume) argued in essence that knowledge has its source outside the individual and that it is internalized through the senses. They further argued that the individual at birth is like a clean slate, on which experiences are "written" as he grows up. As Locke expressed it in 1690: "The senses at first let in particular ideas, and furnish the yet empty cabinet, and the mind by degrees growing familiar with some of them, they are lodged in the memory. . . ." (1947, p. 22)

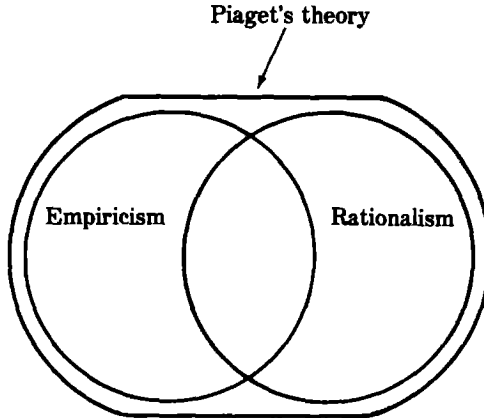
Rationalists such as Descartes, Spinoza, and Kant did not deny the importance of sensory experience, but they insisted that reason is more powerful than sensory experience because it enables us to know with certainty many truths that sensory observation can never ascertain. For example, we know that every event has a cause, in spite of the fact that we obviously cannot examine every event in the entire past and future of the universe. Rationalists also pointed out that since our senses often deceive us in perceptual illusions, sensory experience cannot be trusted to give us reliable knowledge. The rigor, precision, and certainty of mathematics, a purely deductive system, remains the rationalists' prime example in support of the power of reason. When they had to explain the origin of this power, rationalists ended up by saying that certain knowledge or concepts are innate and that they unfold as a function of maturation.

Piaget saw elements of truth and untruth in both camps. As a scientist trained in biology, he was convinced that the only way to resolve epistemological problems was to study them scientifically rather than by speculation. With this conviction, he decided that the best way to study the nature of empirical knowledge and reason in man was to study the development of knowledge in children. His study of children was thus a means to answer epistemological questions scientifically.

The relationship among empiricism, rationalism, and Piaget's theory is shown in figure 2. The best way to explain Piaget's position may be by comparing the outer oval of this figure with the overlap between the two

Figure 2

PIAGET'S THEORY IN RELATION TO
EMPIRICISM AND RATIONALISM



circles inside, which represent empiricism and rationalism. This overlap refers to the fact that empiricists recognized the importance of reason, and rationalists did not deny the necessity of sensory input. Piaget's theory is different from this overlap in that it states that observation and reason are not just important in such a juxtaposed way, but that neither can take place without the other.

What does this statement mean? Piaget makes a fundamental distinction between physical knowledge and logico-mathematical knowledge. Physical knowledge refers to knowledge of objects which are "out there" and observable in external reality. The source of physical knowledge is mainly in objects. The only way in which a child can find out the physical properties of objects is by acting on them materially and mentally and discovering how they react to his actions. For example, by dropping a ball and a glass on the floor, the child finds out how the objects react differently to the same action. Since it is with his senses that the child observes the reactions of objects, physical knowledge is partly empirical knowledge.

An example of logico-mathematical knowledge is knowing that there are more beads than red beads in the world. While the source of physical knowledge is at least partly in objects, the source of logico-mathematical knowledge is in the child. I would like to clarify this statement by taking the example of the simplest relationship between two objects, such as a red bead and a green one of the same size, both made of wood. The two beads can be considered "different." In this situation, the relationship "different" exists

neither in the red bead nor in the green one, nor anywhere else in external reality. This relationship exists in the head of the person who puts the objects into relationship, and if he did not put the objects into this relationship, the difference would not exist for him. It is in this sense that the source of logico-mathematical knowledge is in each child. The two beads can also be considered "the same." In this case, the sameness exists neither in one bead nor in the other, but in the head of the person who puts the objects into this relationship. A third example of a relationship created by the child is "two." Again, the twoness exists nowhere in external reality, but in the head of the person who puts the objects into this relationship. Logico-mathematical knowledge is constructed by coordinating these relationships that have their origins in the mental actions of the child. It is by coordinating the relationships of "same," "different," and "more" that the child comes to deduce that there are more beads than red ones.

The above dichotomy is actually an oversimplification of Piaget's theory, because according to him, physical knowledge cannot be constructed outside a logico-mathematical framework, and conversely, the logico-mathematical framework could not be constructed if there were no objects in the child's environment to put into relationship. To recognize a bead as being red, for example, the child needs a classificatory scheme of "red" as opposed to "all other colors." To recognize a round wooden object as a bead, likewise the child needs a classificatory scheme of "beads" as opposed to "all other objects." If the child did not have this classificatory scheme, or, more broadly, a logico-mathematical framework, every fact would be an isolated fact, unrelated to the rest of his knowledge. This is why I stated earlier that the source of physical knowledge is *mainly*, rather than *entirely*, in objects. Empirical "facts" cannot be read from reality without a classificatory framework.

Piaget's theory can be called interactionist, because according to him, knowledge comes not directly from the environment, as claimed by empiricists, but rather through the interaction between the object in the environment and the knowledge that the subject brings to the situation. For example, a baby bottle is not the same object for 1-month-old subjects and those at ages 1, 7, and 25 years. Likewise, at age 18, a car is usually not the same object for boys and for girls. In Piaget's theory, there is no such thing as a stimulus or a fact independent of a network of relationships into which facts are assimilated. It is not the stimulus that automatically stimulates the subject. Rather, it is the subject who acts on the object and transforms it when he observes it.

Piaget's theory is not only interactionist, but also constructivist. It is obvious enough that the knowledge a subject gets from an object depends on what he already knows. What is not so obvious is that this knowledge was created through a constructive process from the inside rather than through an additive process from the outside. To explain Piaget's con-

structivism, it is necessary to discuss a third aspect of knowledge in addition to physical and logico-mathematical knowledge, namely, social (conventional) knowledge. It is also necessary to discuss the logico-arithmetical and spatio-temporal frameworks around which the totality of the child's knowledge is constructed.

Examples of social knowledge are the facts that there is no school on Saturdays and Sundays, that December 25 is Christmas Day, that a bead is called "bead," and that one sometimes shakes hands with another person. These truths have their ultimate source in the conventions worked out by people.³ Since these truths are manmade, the only way a child can find out about them is from people.

Social knowledge is like physical knowledge in that it is knowledge of content and has its source mainly in external reality. I say "mainly" again, because social knowledge is constructed not directly from external reality, but from within, through a logico-mathematical framework in interaction with the environment. Without a logico-mathematical framework, the child would not be able to understand any convention, just as he would not be able to recognize a wooden object as a red bead. For example, to understand that certain words are considered "bad," the child has to distinguish "bad words" from "those that are okay." To understand that there is no school on Saturdays and Sundays — to cite another example — the child has to structure events into "days," dichotomize the days into "school days" and "days when there is no school," and coordinate this dichotomy with the cyclic order of seven different days.

The reader may have noticed that physical and social knowledge are mainly empirical knowledge. Logico-mathematical knowledge, on the other hand, represents the rationalist tradition.

The two examples of logico-mathematical knowledge given so far are knowing that there are more beads than red ones and that there are more animals in the world than dogs. It is now necessary to clarify the relationship between logico-mathematical knowledge and the logico-mathematical framework that is necessary, for example, to recognize a certain object as a red bead.

Our knowledge is organized around two frameworks, a logico-arithmetical framework and a spatio-temporal framework. When Piaget speaks of the logico-mathematical framework, he is lumping the two frameworks together. (Mathematics includes geometry, which grows out of the spatio-temporal framework.) It has been argued above that a classificatory scheme (part of the logico-arithmetical framework) is necessary for a child to recognize each object in the environment. But objects exist in space and time, and we need a spatio-temporal framework to locate objects and events in these ways. Space and time are completely irrelevant to the logico-arithmetical organization of knowledge. For example, there are more animals than dogs regardless of how these objects are arranged on the globe. To

compare "more dogs" with "more animals," the child must do simultaneously two opposite things that can happen only consecutively in the material world — divide the whole into parts and reunite the parts. While space and time are thus irrelevant to the logico-arithmetical organization of knowledge, they are indispensable in physics, history, and geography.

While many rationalists stated that certain ideas, such as those of space, time, causality, and number, are innate, Piaget proved that the logico-arithmetical and spatio-temporal frameworks are constructed by each child. The construction of the former has already been alluded to in the example of the classificatory scheme that the child constructs as he learns about every object in his environment, such as "bead" as opposed to "every other kind of object" and "dog" as opposed to "every other kind of object." It has also been shown that this classificatory framework evolves into a hierarchical organization as the child coordinates part-whole relationships based on the sameness and differences he sees among objects.

To illustrate the child's construction of the spatio-temporal framework, I would like to give one example each from *The Child's Conception of Geometry* (Piaget, Inhelder, & Szeminska, 1948, Chapter 7) and *The Child's Conception of Time* (Piaget, 1946). In the task concerning the structuring of space, the child was given two white sheets of paper, one with a dot, as shown in figure 3(a). He was also given a variety of instruments such as a pencil, ruler, stick, strips of paper, and bits of string, and was asked to make a point on the blank sheet so that it would look exactly like the other sheet. Four-year-olds (level I) drew the point by visual inspection of the position, without measuring anything. At level II, children began to use the ruler, but made only one diagonal measurement, usually from the closest corner, as shown in figure 3(b). At level IIIB, around age 9, they finally became able to draw the point at the exact spot by making two measurements, as shown in figure 3(c). This behavior is evidence of a system of coordinates that the child has constructed. When this system is present, the child knows that it is necessary to measure two distances perpendicularly to the edge of the paper.

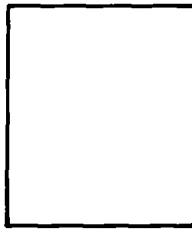
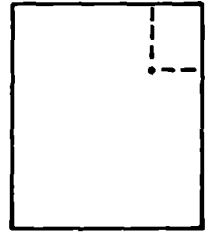
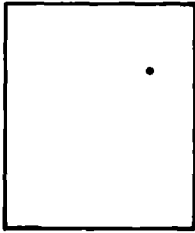
Let us look at how 4-year-olds read certain "facts" before constructing a coherent deductive system of time. Piaget asked a typical 4-year-old, "Who will be the older of you two when you grow up, you or your baby sister?" The answer was "I don't know." The rest of the conversation went as follows:

Is your Granny older than your mother? *No.* Are they the same age? *I think so.* Isn't she older than your mother? *Oh no.* Does your Granny grow older every year? *She stays the same.* And your mother? *She stays the same as well.* And you? *No, I get older.* And your little sister? *Yes!* (p. 221).

We can see in this conversation that without a coherent system of time, the child is limited to empirical knowledge and cannot deduce that the difference

Figure 3

CHILDREN'S WAYS OF LOCATING A POINT ON A
RECTANGULAR SURFACE



(a)

(b)

(c)

in age between her sister and herself will always remain the same. Neither can she deduce that her grandmother is older than her mother, and that the two get older just as children and babies do.

The logico-arithmetical and spatio-temporal frameworks are created by the child by reflective abstraction (and equilibration). Piaget makes an important distinction between reflective and empirical (or simple) abstraction. In empirical abstraction, the child focuses on a certain physical property of the object and ignores the others. For example, when he abstracts the color of an object, he simply ignores the other properties, such as weight and the material with which it is made. Reflective abstraction, in contrast, involves the creation of relationships, such as "the same," "different," and "two," between or among objects. Relationships, as stated earlier, do not have an existence in external reality. The term *constructive abstraction* might thus be better than *reflective abstraction* in that it indicates that the abstraction is a veritable construction by the mind.

I would like to cite one example each of physical and social knowledge to illustrate the importance of the logico-arithmetical and spatio-temporal

frameworks in the construction of knowledge of content. The first example concerns why a wooden ball floats while a key and nail sink in water.

DUF (7;6): "That ball?" — *"It stays on top. It's wood; it's light."* — "And this key?" — *"Goes down. It's iron; it's heavy."* — "Which is heavier, the key or the ball?" — *"The ball."* — "Why does the key sink?" — *"Because it is heavy."* — "And then the nail?" — *"It's light but it sinks anyway. It's iron, and iron always goes under."* (Inhelder & Piaget, 1955, p. 29)

This child's thinking is full of contradictions. When his thinking becomes better structured, he will become aware of the contradictions and will begin to eliminate them. By thus eliminating every factor except the weight and size of the objects and putting them into relationship, as shown in figure 4, he will realize that although the larger the object, the heavier it tends to be (the X's in this figure), some small objects are heavy and some large ones are light.⁴ With this realization, he is on his way to constructing the concept of

Figure 4

THE CLASS-INCLUSION STRUCTURE
INVOLVED IN THE CONSTRUCTION OF SPECIFIC GRAVITY

	Small	Large
Heavy		X
Light	X	

specific gravity. Specific gravity is not observable and must be constructed by the child. Without the structure of class inclusion and seriation, the child cannot possibly construct this concept. Specific gravity is an example of knowledge created by the logico-mathematization of observable facts.

The second example of the importance of the logico-arithmetical and spatio-temporal frameworks in the construction of knowledge concerns children's notions of a country, a town, and nationality. Piaget (1951) found that until 7 or 8 years of age, children may assert that Geneva is part of Switzerland, but think of the two as situated side by side, as can be seen in the following interview.

Claude M. 6;9: What is Switzerland? *It's a country.* And Geneva? *A town.* Where is Geneva? *In Switzerland.* (The child draws the two circles side by side but the circle for Geneva is smaller). *I'm drawing the circle for Geneva smaller because Geneva is smaller. Switzerland is very big.* Quite right, but where is Geneva? *In Switzerland.* Are you Swiss? *Yes.* And are you Genevese? *Oh no! I'm Swiss now.* (p. 40)

The child knows the words *country*, *town*, and *in Switzerland*, but below this surface is poorly structured social knowledge.

In sum, as shown in figure 2, Piaget proved that knowledge does not come directly from the outside through the senses, as claimed by empiricists. Although his position is on the rationalist side of the fence, he disproved the existence of innate ideas that many rationalists postulated. By demonstrating that each child constructs the basic frameworks of knowledge in interaction with the environment, he proved that reason is not innate in man, but is the result of his creation. The better these frameworks are structured, the more accurate and elaborate is the information that a person can get from reality. More accurate, elaborate, and well-organized information in turn constitutes better structured logico-arithmetical and spatio-temporal frameworks.

As an educator, the most fundamental point I get from all the books by Piaget is constructivism. The view that knowledge is acquired by construction is radically different from the empiricist assumptions on which education has been based for centuries. I would now like to turn to the educational implications of this point.

Implications of Constructivism for Education

Empiricist assumptions are reflected almost everywhere in education. For example, by considering the learner to be like an empty glass, educators have arranged classes into neat rows, like rows of empty glasses, to be filled and passed on from one grade level to the next in an assembly-line fashion. In each grade, the teacher tries to fill all the glasses up to a certain level

before giving them to the next teacher. This pouring of knowledge implies that the teacher is like a giant funnel that has collected all the wisdom of the past and selects from this repertoire what to teach, with what organization, and in what sequence. The neat rows of desks may have disappeared from many classrooms, but the pouring of knowledge from the outside continues, or is even intensified, with behavioral objectives, lesson plans, verbalism, and the acceptance of only the "right" answer. In the moral realm, obedience is obtained by using privileges, gold stars, citizenship awards, and the detention hall.

Programmed instruction and behavior modification are more recent refinements of the empiricist tradition of compartmentalizing subject matters, presenting them in the "right" sequence, and insuring "correct" internalization. Behaviorism came out of the empiricist tradition and studies observable behavior in relation to observable independent variables. Behaviorists are thus interested in the prediction and control of behavior without trying to understand what goes on in the learner's head. Educators who think that programmed instruction and behavior modification are innovative do not realize that these are only technological refinements that intensify old traditions.

Many critics and reformers have come and gone against the background of this tradition. For example, Rousseau (1780) opposed the excessive verbal instruction that he saw. Froebel (1885) insisted that the goal of education cannot be imposed on the student, because each person is like a plant that unfolds. Dewey (1902) opposed the fragmentation of the curriculum into subjects and lessons and argued that the curriculum should be rooted in each student's interests. More recently, we have seen a rash of protests from authors such as Dennison (1969), Goodman (1962), Herndon (1968), Holt (1964), Kohl (1967), and Silberman (1970). These authors based their pedagogical beliefs on empathic observation and opinion rather than on a scientific theory. Their philosophy can nevertheless be recognized as unmistakably having elements of constructivism.

Most reformers have run small, marginal schools which have not lasted very long. The reason for this marginality is that reformers' convictions have been based on personal opinions rather than on scientific theory, with the results that (a) they have not been able to convince the majority of professional educators, and (b) they have not developed or evaluated their own teaching with theoretical rigor. A notable exception to this statement is the Eight-Year Study (Aiken, 1942).⁵ Frequently, disagreements have developed among the proponents, especially after the death of the leader. Without a scientific foundation, one opinion is as good as another.

The following is an example of the kind of rationale found in Dewey's writing. The last four sentences particularly reflect a constructivist point of view, but they can hardly be expected to convince the majority of pro-

fessional educators, who believe that education consists of putting subject matters into more or less empty glasses.

The child is the starting-point, the center, and the end. His development, his growth, is the ideal. It alone furnishes the standard. To the growth of the child all studies are subservient; they are instruments valued as they serve the needs of growth. Personality, character, is more than subject-matter. Not knowledge or information, but self-realization, is the goal. To possess all the world of knowledge and lose one's own self is as awful a fate in education as in religion. Moreover, subject-matter never can be got into the child from without. Learning is active. It involves reaching out of the mind. It involves organic assimilation starting from within. (1902, p. 9)

Below is an example from the writing of a teacher who also came to a constructivist conclusion. Again, however, such a private view can be taken only as the opinion of an idealist.

After all I have said and written about the need for keeping children under pressure, I find myself coming to realize that what hampers their thinking . . . is a feeling that they must please the grownups at all costs. The really able thinkers in our class turn out to be, without exception, children who don't feel so strongly the need to please grownups. . . . They don't work to please us, but to please themselves. (Holt, 1964, pp. 39-40)

I do not want to imply that personal beliefs have no value. On the contrary, I admire the educators who have been autonomous and courageous enough to have convictions that go counter to the prevailing point of view. What I am saying is that reform must go beyond personal opinions, because opinions are not enough to change the minds of those in the overwhelming majority who have empiricist beliefs. Without a scientific foundation, the unconventional opinion of a few idealists can be taken only as a minority opinion or a passing fad. The "back to the basics" and "back to strict discipline" philosophy has always survived in the mainstream of education.

It is well known that public schools have failed and continue to fail, especially in the education of the poor, disadvantaged, and certain minority groups. But public education goes on with an incredible array of diffuse, implicit, and contradictory theories. An example of such theories is that when we succeed in teaching something, we attribute this success to our teaching. But when we fail to teach something, we say that it is because the child is not ready or mature. If the cause of our failure is attributed to the child, the cause of our success must also be found in the child.

The reason why educators often cannot see this contradiction is the relationship between constructivist and empiricist-behaviorist beliefs that remain implicit and diffuse in their thinking. Teaching usually does produce observable changes. But when children seem to be learning, we must ask which children are learning, what they are learning, and how.

The children who seem to learn easily are generally the middle- and upper-middle-class children who have already constructed a great deal of knowledge outside of school. Research such as that of Okada, Cohen, and Mayeske (1969) has shown over and over that within each ethnic or racial group at each grade level, higher socioeconomic groups have higher achievement scores.

What do children learn when they seem to be learning? The advanced students tend to learn in the way the teacher intended. Too often, however, children learn only the "right" answer, the answer that the teacher wants, and the teacher remains under the illusion that teaching has been successful. As quoted earlier from Holt, the most important thing for many children is to please the adult. The learning of right answers, motor skills, and specific information that must be memorized (such as the multiplication tables and spelling, mentioned earlier) can be explained at least in part by behaviorism (the inner circle in figure 1(c)). Intelligent learning with understanding, as well as the complete absence of learning, can be explained only by constructivism (the outer oval in Figure 1(c)).

An example of an extreme empiricist-behaviorist view can be seen in Engelmann (1971) and Kamii and Derman (1971).⁶ In this study, Engelmann argued that if children do not know something, it is because they have not been taught that fact or concept. He chose to teach the concept of specific gravity, among other things, to a group of 6-year-olds, and agreed to let me give the posttest to these children. According to Piaget (Inhelder & Piaget, 1955), as we saw earlier, it is not possible to understand specific gravity before the period of formal operations. I was therefore not surprised that the children had memorized only an overlay of verbalism. They had been taught to say that if something sinks, it sinks because "it is heavier than a piece of water the same size," and if it floats, it floats because "it is lighter than a piece of water the same size." Underneath the surface was the same kind of preoperational thinking found in any 6-year-old. In fact, in my opinion, the children were harmed by this teaching because they were taught to say things that contradicted what they honestly believed.⁷ Below is an example, using a big cake of Ivory soap (which floated the day before) and a little cake of soap (which sank):

- Examiner: Did both of these sink yesterday?
 Child: Yes.
 Examiner: Feel this big one and this little one in your hands.
 Child: (Feeling the weight of the two pieces) The big one feels heavier.
 Examiner: Will both of them sink?
 Child: I think the little one will sink, too. . . .
 Examiner: Why?
 Child: Because they are both soap.
 Examiner: You put them in the water and see what happens.

- Child: (Finding out that the big one floated and the little one sank) I forgot yesterday!
- Examiner: Remember you said the big one was heavier?
- Child: The big one must be lighter, and the little one must be heavier. (Kamii & Derman, 1971, p. 140)

Engelmann agreed completely with the facts obtained in the posttest, but he drew the opposite conclusion. For him, the cause of failure lay in the way he had taught, and he stated that with more time to perfect the program, he could bring the children up to the desired criterion.⁸

This type of verbalistic teaching to produce the "right" answer can be found in less extreme form in every school in the nation. For example, if a first grader has difficulty answering " $___ + 2 = 6$ " but not " $2 + 4 = ___$ " most first-grade teachers engage in the kind of teaching advocated by Engelmann. The actual teaching of the average teacher may be less forceful, but the underlying, implicit theory is empiricist-behaviorist.

Instruction must mesh with and support the natural constructive process. The teaching of specific gravity can result in solid learning when the adolescent is already at a certain level of development. Instruction in reading, too, can produce easy learning when a 6-year-old is at a certain level.

In the moral realm, schools try to get values internalized from the outside by giving orders and using sanctions. Children are told what to learn and when, and the school day is filled with orders and rules to obey — no talking, fold your hands, get in a line for recess, walk with your arms crossed, no ball-playing here, no throwing of snowballs, and there will be no recess for Johnny today because he talked in class.⁹ Schools use behaviorist techniques that are conducive to obedience, or the morality of heteronomy. If some children develop the morality of autonomy, this is because of social interactions at home that permit the autonomous construction of values.

Piaget's theory is a descriptive and explanatory one, and, as he has often stated, a pedagogy cannot be deduced directly from this theory. A great deal of theoretical and experimental work therefore remains to be done to develop a Piagetian pedagogy for real classrooms in real schools. The details of such work are beyond the scope of this article, and the reader is referred to Kamii (in press) and Kamii and DeVries (1978; 1977; 1976) for examples. Just as all sciences and all children develop by going through one stage after another of being "wrong," a Piagetian pedagogy can develop only by successive approximation. The nation's schools are plagued by enormous problems ranging from illiteracy to apathy, poor discipline, alienation, and vandalism. Obviously, not all the solutions to these problems can come out of Piaget's theory. However, I am convinced that a fundamental reconceptualization of curriculum, methods of teaching, and children's development of autonomy will take us far closer to solutions than any other theory.

Footnotes

¹In extreme cases, sanctions result in the following three types of outcome: (a) calculation of risks (or of the cost of getting a reward), (b) blind conformity, and (c) revolt, usually in adolescence. The reader interested in Piaget's ideas about how to foster the development of autonomy is referred to Chapter 3 of *The Moral Judgment of the Child*.

²I have seen many psychologists who changed from behaviorist or associationist views to a Piagetian outlook. However, I have never known of a Piagetian who later become a behaviorist. Once a person understands a more adequate theory (e.g., the heliocentric theory), he cannot go back to a more limited outlook (e.g., the geocentric theory).

³Piaget never designated social or conventional knowledge by a name, but he unmistakably referred to it, especially in *The Moral Judgment of the Child* and his discussion of the sign (i.e., language, which is a conventional system).

⁴Figure 4 is presented as a double dichotomy to simplify the discussion. Actually, both weight and size must be seriated. The relationship between the weight and size of objects is, therefore, more complex than this double dichotomy implies.

⁵The purpose of this study was to find out if students could do better in college if they did not take certain high-school courses usually required for college entrance and instead engaged in more integrated, critical, and indepth study. The conclusion can be found in the following summary: "It is quite obvious from these data that the Thirty Schools graduates, as a group, have done a somewhat better job than the comparison group whether success is judged by college standards, by the students' contemporaries, or by the individual students" (Aiken, 1942, p. 112).

The unusual features of this experiment were that (a) almost 30 reputable high schools and 25 colleges and universities participated, including Harvard, MIT, and Princeton, and (b) principles of progressive education were clearly delineated, and rigorous evaluation took place on a relatively long-term basis (eight years).

⁶Englemann is the principal developer of the well-known DISTAR method (Englemann, Osborn, & Englemann, 1969), which is widely used in Head Start and Follow Through programs.

⁷They also learned to distrust their own thinking. Undermining children's confidence can have detrimental long-range effects.

⁸It has been ten years since Mr. Englemann made this statement. I am still hoping for an opportunity to evaluate another version of his program.

⁹In Piaget's theory, social interaction, or, more specifically, the exchange of opinions, is considered indispensable for children's development of logic and moral rules. For further detail, the reader is referred to *The Psychology of Intelligence* (Piaget, 1947, Chapter 6), and *The Moral Judgment of the Child* (Piaget, 1932, Chapter 3).

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