Reflections on Some Work of Jean Piaget

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Jean Piaget is often called the father of constructivism, and a phrase of his—“To understand is to discover” (1973, p. 20)—is often used as the constructivist motto. Various versions of constructivism (e.g., social, radical) now dominate reform efforts in education, and they claim to descend (in varying degrees) from Piaget. Even those who attempt to build a philosophy of learning development in contrast to Piaget’s must in some way deal with his ideas. Thus, it is worthwhile to spend the time and effort behind this paper delving into some of Piaget’s writing.

Learning and the Stages of Development

It is not insignificant that Piaget wrote that to understand is to discover (see above), rather than to learn is to discover. (And this word choice is important to education reformers who follow Piaget because they emphasize teaching for meaning, or in other words, understanding.) For Piaget, learning can indeed take place without discovery. He even admits that the stimulus-response model of Watson and Thorndike accounts for learning—but this type of learning is a particular type and not characteristic of the broader cognitive picture that Piaget was interested in exploring and explaining. Before summarizing the stages of development as put forth by Piaget, then, it is necessary to look more closely at the distinctions he perceived between learning and development.

Learning and Development

When Piaget used the term “learning” in contrast to the term development (as in 1964), he was referring to specific acquisitions of knowledge that were limited to

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1 All references are to Piaget unless otherwise indicated.
particular situations. (This may also be thought of as “learning in the narrow sense.”) For example, a student has learned something about right triangles when s/he can look at a side of measure 3 and a side of measure 4 forming a right angle and recall that the hypotenuse of the triangle has measure 5. This knowledge is specific to the situation and, Piaget admits, can be taught quite effectively using a behaviorist model of education.

By “development” of knowledge, Piaget meant the structures of thought that apply to general situations (1964, p. 7). (This may also be thought of as “learning in the wider sense.”) With regard to right triangles, a student may have developed a way to think about them that includes classifications (e.g., right triangles can be isosceles but not equilateral), general relationships (e.g., the Pythagorean theorem holds), and general properties (e.g., the right angle is a defining characteristic whereas the hypotenuse being the longest side is a derived fact). This cognitive structure is developed and is not the result of specific instruction. How does such development occur?

Contrary to the behaviorists mentioned above, Piaget does not view development as the “sum of discrete learning experiences” (1964, p. 7). Rather, development is “the essential process” and particular instances of learning are a “function of total development.” This notion that “development explains learning” led Piaget to explore and hypothesize the mechanisms of development—there are four.

First, Piaget noted that maturation—the continuation of embryogenesis—is a factor in development. The maturation and physical development of an individual, especially the central nervous system, plays an “indispensable role” (1964, p. 10) in their cognitive development. This was clear to Piaget and is even clearer now as
neurological research has advanced and shows that certain areas of the brain are related to certain types of thought which, therefore, cannot advance without the corresponding brain maturity. Piaget noted, however, that maturation of this sort does not alone explain cognitive development because there is substantial variation in development between cultures, even though they are at the same levels of maturation.

Second, Piaget identified experience as a factor in development. Here he was referring to experience with objects in the physical world. For example, a child’s various experiences with grasping, pushing, and feeling a wooden block play a role in the development of a cognitive structure regarding wooden blocks. It should be noted at this point that Piaget distinguished between two types of experience: physical experience and logical-mathematical experience. The former refers to experience acting upon objects and drawing knowledge from those actions. The latter refers to experience in which the knowledge is gained from the action itself and not the objects involved. This distinction will resurface below in the discussion of Piaget’s stages of development. At this point I will just point out that it might have been clearer for Piaget to make this a distinction, not of experience, but of sources of knowledge from experience, with physical experience being re-termed an object-source and logical-mathematical an action-source.

The third factor of development is social transmission. Social transmission occurs when, for instance, an adult communicates some piece of information to a child. This factor of development is limited, however, because it is dependent upon the child’s ability to receive and comprehend the communication.
The fourth factor of development, which Piaget describes as the “fundamental one” (1964, p. 12), is *equilibration*. (In a sense, it was misleading for Piaget to list this on the same level as the other factors of development because equilibration mediates the others.) Equilibration is the process by which children reconcile their experiences and their mental schemes (psychological structures that organize experience). This reconciliation can take the form of assimilation or accommodation (or often both).

Assimilation occurs when experiences (physically with the world or communicatively with other individuals) are incorporated into existing schemes. For example, imagine a student who has a scheme for rational numbers characterized by the notion of one number on top of another number. Now imagine the student coming across $-\frac{2}{5}$ for the first time and deciding that it is a rational number. This particular fraction has been assimilated into the student’s rational number scheme. Accommodation, on the other hand, occurs when schemes are modified based on experience. An example of this can be found with another student who has a scheme for rational numbers characterized by the notion of one positive integer on top of another positive integer. If this student encounters $-\frac{2}{5}$ and realizes that it too is a rational number, then the scheme will have to be modified to accommodate the negative number.

In summary, Piaget contended that the cognitive schemes or structures children have for organizing their experience develop based on maturation, experience, social transmission, and above all, equilibration. Experiences are assimilated into existing schemes and schemes are modified to account for new experiences. This development, however, does not merely proceed incrementally or quantitatively; there are
qualitatively different stages of cognitive development, and it is to these stages that we now turn our attention.

The Stages

The sensorimotor stage spans birth until approximately age 2 and is characterized by the lack of representations for persons or objects; thus interface with and intelligence about the world are in the form of actions. Initially, infants are unable to differentiate themselves from their environments and are equipped primarily with reflexes. Throughout this first stage, the separation between the individual and the rest of the world is perceived, reflexes become coordinated, causality is recognized, and means-end sequences are developed. Moreover, the “group of displacements” (Piaget & Inhelder, 1969, p. 16) is organized and developed by the child and used as a framework for objects in physical space. The invariant in this group is the existence of the object itself, and the recognition of this invariant by the child leads to the concept of object permanence—one of the important accomplishments of the sensorimotor stage.

The preoperational stage spans ages 2 to 7, approximately, and is characterized by the child’s developing use of symbols (and signs) to represent objects and events in the world. Although the severe narcissism of infancy has been overcome by this stage, there still exists an egocentrism of perspective wherein the preoperational child has difficulty seeing the world from another’s point of view. Furthermore, as illuminated by many of Piaget’s tasks, children in this stage fail to conserve liquid quantity, number, and mass. In other words, preoperational children have not yet comprehended quantity as an invariant in the group of physical transformations (e.g., pouring, stretching, thinly rolling).
The *concrete operational stage* spans ages 7 to 11, approximately, and is characterized by the development of mental operations, as the name suggests. An operation is an interiorized, generalized, reversible action (1964, p. 7; Piaget & Inhelder, 1969, p. 96). For example, a child may have had many experiences joining or combining objects in the world. These physical actions can interiorized as a single, general mental action. The child can also come to understand that joining is undone by separating and in so doing acquire an operation that we might call “addition.” Operations such as addition can be powerfully used by concrete operational children to solve problems and reason about the world. Our child above, for instance, can solve addition problems without needing to rely on physical models of the situations in questions. Thinking in this stage is still limited, however, as children have difficulty thinking in hypothetical terms or outside of the “here and now.”

The *formal operational stage* spans approximately age 11 through adulthood and is characterized by abstract thought and deductive reasoning. Formal thinkers are able to apply their mental operations to abstract entities in hypothetical situations. In mathematics, for example, a student in the formal operational stage would be able to successfully consider and work within spaces different than familiar Euclidean space.

Thus far, I have briefly laid forth Piaget’s notions of learning and development, the mechanisms he identified as underlying development, and the stages through which he hypothesized children’s thinking progresses. What does this theory contribute to issues of teaching and learning? It is to this matter that I now turn.

Piaget and the Classroom
As a teacher of mathematics, I can identify several ways in which Piaget’s theory of cognitive development can influence (and hopefully improve) classroom practice, the first of which comes from the initial distinction between learning and development. It is important to keep in mind that discrete pieces of narrow learning do not necessarily lead to development on the part of the student. I have seen this failed implication many times in mathematics classrooms where some students cling to a vast array of allowable algebraic manipulations but have not developed an adequate scheme of equality, and in university mathematics tutoring centers where some students mindlessly apply rules of differentiation with no understanding of what these rules produce or why they work. In both of these cases, it is clear to me that the students have learned in the narrow sense but not the wider sense.

Piaget’s theory not only provides a language for describing such problems in mathematics learning, but also supplies tools with which to avoid them. One that seems especially important to me is based on the notion of equilibration. As mathematical concepts are introduced and encountered in the classroom (note that I am assuming mathematics classrooms are a place in which mathematical concepts are actually encountered), students formulate (or refine) schemes with which they organize these encounters. As new experiences arise concerning a particular concept, these experiences are either assimilated to the existing schemes or the schemes are modified to accommodate the experience. A teacher who is mindful of these possibilities may be able to better guide the experiences in a way that results in a sophisticated and robust scheme.
This paper began with a quote from Piaget that, on the face of it, seemed to be steeped in classroom implications. The full passage is this: “To understand is to discover, or reconstruct by rediscovery, and such conditions must be complied with if in the future individuals are to be formed who are capable of production and creativity and not simply repetition” (1973, p. 20). However, the term “discover” did not appear even once in the treatment above of the factors and stages of development. What, then, did Piaget mean by “discover”? I posit that discovery has two facets; using the language of Piaget’s theory of development, I say that discovery consists of active (on the part of the student) arrival at a state of disequilibrium and active (on the part of the student) equilibration. This definition does not mean that the arrival at disequilibrium or the equilibration has to be a solitary act—cooperative action can still result in discovery—but it does preclude a student being led directly to or directly through disequilibrium.

Now, this interpretation of discovery seems to point to the importance of having students actively engage their existing schemes with new experiences in the classroom, designing lessons in which disequilibrium can be arrived at, and cultivating environments in which equilibration can be achieved, resulting in modified cognitive structures. Piaget said that that learning of this sort results in understanding. He also seems to have said that understanding only arises through discovery (though the logic of his quotation is not clear due to the particular phrasing). One may debate this by saying that a state of disequilibrium or the process of equilibration can be prompted through social transmission—that is, a non-discovery process—and understanding can result from this disequilibrium and equilibration regardless of what led to it. While this is true, the point is subtle because equilibration does not take place, by definition, until the
student actively engages in it—so it may be the case that the student did not discover the entirety of the phenomena, but understanding depends upon the student picking up the reigns of discovery at some point.

As an example of this subtle issue, consider three situations concerning the classification relationship between rectangles and squares. In the first case, the teacher leads a student through considerations of different quadrilaterals and then asks whether or not the squares are rectangles. After a moment, the teacher declares that squares are rectangles because they have four right angles. In this case, it is possible that the student was not listening and so does not understand the relationship between squares and rectangles; it is also possible that the student was listening and memorized the teacher’s final explanation but does not truly understand the relationship. It is possible that the student was engaged in a mental process of discovery along with the teacher, but it is also possible that this did not happen. In the second case, the teacher and a student consider different quadrilaterals and then the teacher asks if squares can also be rectangles. The student is perplexed by this question but using the shapes available and the guidance of the teacher is able to become convinced that all squares must also be rectangles. In this case, the student did not discover the situation of disequilibrium but was led to it by the teacher. The student did, however, discover the resolution to the situation and so likely understands the relationship in question. In the third case, a student works independently classifying quadrilaterals and realizes that she doesn’t know whether to put the squares with the rectangles or in their own separate pile. She considers this problem and, using her knowledge of squares and rectangles, correctly modifies her scheme for rectangles to include squares. In this case, the student
discovered the disequilibrium and its resolution so we can be confident that she understands the classification relationship between squares and rectangles.

Whether or not Piaget is justified in his use of the term “discover” (that is, based on the examples above, he may simply mean that to understand is to actively work to equilibration), the broader point is that understanding is tied to students’ actively working to make sense of their experiences and to integrate their discrete, “narrow” pieces of knowledge. This sense-making process, comprising assimilation and accommodation, is essentially a path of discovery for every individual student.
References


