Connecting Cognitive Development and Constructivism: Implications from Theory for Instruction and Assessment

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This paper provides an overview of the developmental theories of Dewey, Piaget, Vygotsky, and Bruner that provide the basis for the educational application of constructivism. Activities for developing instruction and assessment built on constructivistic theories are also discussed.

A review of the last fifteen years of literature reveals the attempt to consolidate the findings of a number of cognitive psychologists and philosophers who contend that several major assumptions of the information processing approach to cognition are incomplete. For example, one of the assumptions of this approach is that knowledge and competencies of thinking are situated within the individual and can be studied independently of the situation within which they are used (Bruner, 1990). Alternatively, Greeno (1989), a leading proponent of situated learning, proposes that thinking is a result of interaction between the individual and the environment. Greeno argues that person/environment interactions are of such a complexity as to make attempts to discover generalized cognitive processes quite irrelevant. Rather he suggests a need to study how a student's innate abilities are used to develop knowledge and thinking competencies through interaction with specific environments. This position suggests that the information processing model may be adequate to explain current understandings of how memory operates, but it does not fully describe or predict differences in cognitive development. Situated models like Greeno's serve to highlight an ecological model for cognitive development that focuses on how individuals construct meaning from interactions with their environments (Huitt, 2003).

As in every domain of human development, there are three major questions that are addressed: what is the role of biology, what is the role of experience, and how can the environment be arranged so as to best address the interaction between these two factors? John Dewey, Jean Piaget, Lev Vygotsky, and Jerome Bruner, researchers who provide the theoretical underpinnings for the increasingly popular constructivistic approach to the teaching/learning process, have different responses to these questions. However, the group of theorists discussed in this paper would subscribe to this questioning of assumptions. While they may disagree as to the emphasis on the individual or environment, they would all recognize the importance of studying person/environment interactions. This acknowledgment increases the complexity of their findings, making them that much more difficult to understand and use in guiding and assessing students' cognitive development. Consequently, there are many questions that remain unanswered. This paper will provide an overview to theories that provide a theoretical underpinning to the constructivistic approach, as well as practical suggestions for classroom practice and methods of assessment and evaluation germane to the constructivistic approach.

John Dewey

John Dewey (1998) was an American psychologist and philosopher who promoted the value of personal experience in learning. He placed relatively little emphasis on maturational factors and taught that human beings understand the world through interaction with their environment and, thus, knowledge is constructed by the individual. Dewey (1944) proposed that a primary function of schooling was to prepare young people to live in a democratic society and that one's reflection on personal experiences would provide the foundation for the development of the necessary attributes for successful living. He believed the dualistic conceptualization of thinking and doing to be false. Rather he proposed a reciprocal, continuous relationship between thinking and doing that is reflected in the work of the other researchers discussed in this paper (Vanderstraeten & Biesta, 1998). As a leader in the progressive education movement in the early 20th century, his work set the stage for an acceptance of the work of later researchers.

Jean Piaget

Jean Piaget (2001) was a Swiss biologist, philosopher, and behavioral scientist who developed one of the most significant theories in cognitive psychology. His stage theory gained wide acceptance in the 1960s and 1970s as a result of the translations of his work into English and its promotion by influential American psychologists (e.g., Flavell, 1963). His impact on the field of cognitive development cannot be overstated, even though many of the precepts he developed have been criticized by subsequent evidence (Parent, Normandeau & Larivee, 2000).

Piaget described himself as a genetic epistemologist. His work focused on developing a general theory of knowledge, how a child develops a knowledge of his or her world, and the role that biology plays in that development. To Piaget, intelligence is represented by how an organism interacts with its environment through mental adaptation. This adaptation is controlled through mental organizations or structures that an individual uses to represent the world; it is driven by a biological impulse to obtain balance (homeostasis or equilibrium) between those mental organizations and the environment.

Piagetian theory can be discussed in two parts: 1) his theory of adaptation and the process of using cognitive schemes and 2) his theory of cognitive developmental stages (Huitt and Hummel, 1998).

The process of coming to know, the first aspect of Piaget's (2001) theory, starts with the fact that individuals are born with reflexes that allow them to interact with the environment. These reflexes are quickly replaced by constructed mental schemes or structures that allow them to interact with, and adapt to, the environment. This adaptation occurs in two different ways (through the processes of assimilation and accommodation) and is a critical element of modern constructivism. Adaptation is predicated on the belief that the building of knowledge is a continuous activity of self-construction; as a person interacts with the environment, knowledge is invented and manipulated into cognitive structures. When discrepancies between the environment and mental structures occur, one of two things can happen. Either the perception of the environment can be changed in order for new information to be matched with existing structures through assimilation, or the cognitive structures themselves can change as a result of the interaction through accommodation. In either case, the individual adapts to his or her environment by way of the interaction. It is clear that Piaget believed that cognition is grounded in the interface between mind and environment. The result of this interplay is the achievement or working toward a balance between mental schemes and the requirements of the environment. It is a combination of maturation and actions to achieve equilibration that advances an individual into

a higher developmental stage.

Piaget proposed four sequential stages of cognitive development. Other researchers have critiqued his theory, using four criteria implied by it (Driscoll, 2000). First, if each stage is progressive, as he asserts, then each must represent a qualitative (discontinuous) change in cognition, or there must be an obvious, substantial improvement or change when a child moves from one stage into the next. Second, the stages of progression must be consistent for all children across all cultures and societies. If Piaget's theory is true and cognitive development is biologically based, cultural and societal factors should not impact that development. Next, preceding stages must be integrated into later stages of development. As growth occurs in a stage theory model, the abilities and structures from all previous stages should be present and operational at all higher stages. Finally, at any point in development, a child's mental structures or schemes and his or her physical operations join to form a whole unit, and as development occurs, this unit becomes more complex. These four criteria form the backdrop for Piaget's four-staged theory of cognitive development. Because his theory asserts that the stages are age dependent and based on cognitive readiness, the approximate ages for each stage are included in the discussion of each.

Piaget differentiated three types of knowledge that must be present at all stages of cognitive development: physical, logical-mathematical, and social (Driscoll, 2000. Physical knowledge is gained through hands-on interaction with the environment. It deals directly with experience and perception of objects and is very concrete in nature. This type of knowledge can only be gained from personal, direct contact with environmental elements. Logical-mathematical knowledge is an abstract reasoning that is applicable beyond physical interaction with a concrete stimulus. While physical knowledge is discovered, logical-mathematical knowledge is created through actions. It can only be gained by repeated exposure and interaction with multiple objects in multiple settings in order for mental structures to be modified and created. Here, it is the manipulation of objects in different patterns and contexts that allows for generalizations and abstractions to be created. Likewise, social knowledge can only be gained through interaction with others. This type of knowledge is culture specific and its acquisition is based on actions rather than physical perception of objects. These types of knowledge are at work at all stages of cognitive development and are not necessarily hierarchical in nature—as are Piaget's proposed stages of development.

The first stage suggested by Piaget (2001) is the sensorimotor stage. In general, this stage lasts from birth to about two years of age. At this point intelligence is based on physical and motor activity, but excludes the use of symbols. Mobility, crawling, and walking facilitate knowledge acquisition, and progress is shown through the modification of reflexes in response to the environment. One important milestone of this stage is the development of object permanence. Beginning at about 7 months, infants start to understand the concept that objects continue to exist even though they cannot be seen. The end of this stage is marked by the immature use of symbols and language development that signals the progression to the second stage.

The second stage, labeled pre-operational, lasts from about two years of age until approximately seven (Piaget, 2001). It is marked by the demonstration of intelligence through the use of symbols, especially the maturation of language. Children in the pre-operational stage are able to mentally represent objects and events, and at this point in development, memory and imagination are developed. An important signifier of this stage is the ability of a child to do monological, nonreversible thinking; children in this stage can deal with or determine only one aspect of a problem at a time, and they cannot think or process information in a multidimensional fashion. A child's thinking at this stage is also highly egocentric, and even in conversation, he or she will fail to recognize any duality in the exchange of information and certainly will fail to

comprehend any perspective other than their own. The end of this stage is marked by the child's ability to conserve number (i.e., the child knows that spacing of objects does not impact their quantity).

The reaching of Piaget's (2001) third stage, the concrete operational, is evidenced by a child's ability to demonstrate logically integrated thought, and the typical age span for this stage is from seven to eleven. At this point in development, the child's exposure to, and integration of, knowledge has matured such that all three types of knowledge (physical, logical-mathematical, and social) can be used by the child to interact with the environment to a relatively high degree. At this point, intelligence is based on logical and systematic manipulation of concrete objects and related symbols. The child can engage in reversible mental operations (i.e., the child can interact with the environment from more than one perspective). Subsequently, egocentric thinking declines. The major milestone yet to be reached by the concrete operational child, however, is the ability to make abstractions and hypothesize. At the concrete operational stage, his or her development is still limited to the application of knowledge to concrete objects and stimuli.

From eleven years onward, Piaget (2001) presumes that the preadolescent begins the process of attaining the formal operational stage of development. At this stage, intelligence is shown through the logical use of symbols related to abstract concepts. There is typically a return to egocentric thinking early in the period, but the abstractions that this type of thought allows eventually move the individual to a much broader perspective and thinking beyond himself or herself. Siegler (1991) suggests that an important ability of people who reach this stage is that they are able to think abstractly about such issues as truth, morality, justice, and the nature of existence and to provide alternative, competing beliefs about these. Thus, cognitive development becomes a pre-requisite for the acquisition of morality based upon abstract principles.

It is important to note that empirical evidence suggests the formal operations stage is not necessarily reached because of physical maturity (Eylon & Lynn, 1988; Renner and others, 1976). Eylon and Linn (1988) categorize the percentage of high school students at Piaget's developmental levels as shown in Table 1. As is evident most students have not attained the formal operations stage by the time they get out of high school, let alone at age 15 when Piaget states that most young people should have attained it.

Table l. Percentage of Students in Different Piagetian Stages

Age	Grade	Preoperational	Entry Concrete	Advanced Concrete	Entry Formal	Middle Formal
14	8-9	1	32	43	15	9
15	9-10	1	15	53	18	13
16	10-11	1	13	50	17	19
16-17	11-12	3	19	47	19	12
17-18	12	1	15	50	15	19

Piaget's stages have come under significant scrutiny in the years since they were introduced and many theories have added to the scope or particularities of his ideas. Kagan (as cited in Stanton, 1993, p.1) points out that "Piagetian theory fails to account for how and why a child passes from one stage to another, and second, it fails to provide a systematic description of the conceptual structures possessed by the child at each stage." While the theory has often been

amended or refuted, its impact is unquestionable, and many of Piaget's ideas continue to validly describe the process of mental change. Dasen has said that "There may be some discussion about the age at which particular concepts are attained, the possibility that for some individuals this type of reasoning may, in some conceptual areas, remain a potential rather than a performance applicable to all contexts, but it remains that concrete operational reasoning has been found world-wide" (as cited in Suizzo, 2000, p. 847). Further, although new theories of cognitive development have gone beyond Piagetian thinking, they all seem to agree with at least the spirit of Piaget's work that children are spontaneously and actively processing their interactions with the environment in a self-directing manner, using a wide variety of information processing processes to construct a view that is unique to each individual (Flavell, Miller, & Miller, 2002).

One modern extension of Piagetian theory may be found in Case (1985), who provides an excellent example of research that continues to develop Piaget's original framework. He agreed with Piaget that there are developmental stages and that increasingly sophisticated structures develop at each, but he preferred to model mental structures using an information processing approach. Relying on this model, Case suggested that as automaticity increases and more structures are developed, new developmental stages could be reached. He focused on the demands on memory for task performance and suggested that at all levels a person's capacity for gaining knowledge is divided between operating space and storage space. Although he names automaticity in particular, it is suspected that other factors, including biological ones, contribute to developmental increases. Also, he subdivided each of Piaget's stages into four substages. He first introduced these levels in 1980, but in 1985 revised and renamed them as operational consolidation, operational coordination, bifocal coordination, and elaborated coordination (Stanton, 1993).

Lev Vykotsky

The inclusion of society and culture as impactors of cognitive development is most evident in the work of Lev Vygotsky (1978). His work uses social interaction as the framework for all learning and development. To Vygotsky, "the development of the mind is the interweaving of biological development of the human body and the appropriation of the cultural/ideal/material heritage which exists in the present to coordinate people with each other and the physical world" (Cole and Wertsch, 1996, p. 2). There are three major principles underlying Vygotsky's social development theory (Wink & Putney, 2002). First, social interaction plays a critical role in cognitive development in relation to what is learned and when and how learning occurs. This principle asserts that "Without the learning that occurs as a result of social interaction, without self-awareness or the use of signs and symbols that allow us to think in more complex ways, we would remain slaves to the situation, responding directly to the environment" (Nicholl, 1998, p. 1). The second principle associated with this theory is "the idea that the potential for cognitive development is limited to a certain time span" (Kearsley, 2001b, p. 1). Finally, Vygotsky asserted that the only way to understand how humans come to know is to study learning in an environment where the process of learning rather than the product that is the result of learning, is studied.

The impact of society and culture are central to social development theory. Vygotsky (1978) believed that all higher mental functions must first be filtered through an external stage in the form of social occurrences. They are then integrated into an individual's thinking through the

use of language. This "dialectical discovery" is a continuous process that becomes increasingly complex over time (Wink & Putney, 2002, p. 10). Therefore, all higher functions originate as actual interpersonal relationships between individuals.

Vygotsky (1978) believed that two levels of mental functions exist: elementary and higher mental functions. The first are functions that individuals are born with (i.e., no learning is required for their use). These functions require no thought and are naturally occurring such as hunger and sensing. Conversely, higher mental functions include the creation and use of self-generated stimulation such as memory, attention, thinking, and language (Galant, 1998). The transition from elementary to higher mental functions is made through the use of cultural tools. Vygotsky's view is that human beings create cultures through the use of tools and symbols. Culture (and in turn society) then dictates what is valuable to learn and how it is learned. Society, then, is the driving force behind cognitive development. This is a departure from theories that contend that cognitive development proceeds in order to prepare a person to interact with society in a meaningful way. Instead, cognitive development is the internalization of social functions and the conversion of social functions into mental functions (Driscoll, 2000).

The concept in Vygotsky's (1978) theory that each person has an individual range of potential for learning is called the zone of proximal development. This zone indicates that at any point in development, there are three levels of ability that are possible: that which a person can do without guidance or help, that which a person cannot do even if helped, and that which a person can do with help. The measurement of cognitive development, then, cannot be accomplished by a simple evaluation of a task completed by one person. In this theory, it is the potential for development that is important, not the snapshot that can be provided by simply asking a child to complete a task independently. The zone itself is the distance between the actual developmental level as determined by independent problem solving and the level of potential as determined through problem solving under adult guidance or in collaboration with more capable peers (Galant, 1998). This potential moves with an individual as if on a sliding scale throughout life, and, in theory, full development can never be reached. This idea, also, is radically different from stage theorists because it delineates no final destination or developmental stage.

With respect to Vygotsky's (1978) belief that one must study the process of learning rather than the product, he was interested in how a person mediates or actively modifies the stimulus situation as a part of learning. His observations focused on how children go about the process of problem solving and what societal tools are employed in their solutions. In order to assess development, he studied the interaction of subjects with a problem-solving task, but was not necessarily concerned with whether or not a correct solution was achieved. Different developmental levels were demonstrated by the elements such as use of symbols, abstractions, and past experiences. In addition, Vygotsky would often add additional problematic circumstances to a problem-solving task such a mixed language groups in order to understand more about the process of finding solutions (Driscoll, 2000).

Jerome Bruner

Bruner's (1987, 1990) constructivist theory incorporates many of the ideas offered in previous theories. First, he includes the Piagetian notion that cognitive development occurs in progressive stages and that each stage is incorporated and built upon by succeeding stages. Bruner also agrees with Piaget in arguing that categorization and representation are keys to an

individual's cognitive development. His ideas can also be linked to those who propose information processing models in that he suggests development occurs as mental structures become more elaborate and sophisticated through interaction and experience: "learners construct new ideas or concepts based upon their current/past knowledge. The learner selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so" (Kearsley, 2001a, p.1). In addition, his work is considered interactional in a manner similar to that proposed by Dewey and Vygotsky. He is concerned with the sequence of representation (the stages), but he is equally concerned with the role of culture on cognitive development.

There is one fundamental difference between Bruner's (1987) and Piaget's (2001) theories. First, stage theories maintain that cognitive readiness is key to learning and development. According to these, age or biological state dictates what can be learned and how learning can occur. Constructivist theory suggests that it is the translation of the information that dictates what type of information can be processed and how learning can occur. Piaget would say that an individual cannot process certain types of information at certain ages or stages, but Bruner disagrees, stating that certain aspects of any content or principle can be taught to any child. It will likely be necessary, however, to revisit these as the individual acquires more knowledge and capacity.

The other critical piece of the equation for Bruner (1987, 1990) is the impact of culture on learning, and it is with this element of Piaget's theory that he takes issue. According to Piagetian theory, all individuals pass through exact stages and progress in the same ways regardless of cultural or societal differences. This idea, however, is not supported in empirical research (e.g., Renner and others, 1976). It has been shown that "Members of different cultures, because of the specific and unique demands of living in their societies, make sense of their experiences in different ways" (Driscoll, 2000, p. 236), and these differences manifest themselves at variant stages of development. This would seem to indicate, then, that culture and social structure do in fact play a role in cognitive development. Bruner (as cited in Driscoll 2000, p. 236) stated that "Intelligence is to a great extent the internalization of 'tools' provided by a given culture." If a society's tools are different, their categorization structures would also be different, and their representations would be different. Different skills and types of knowledge would be necessary at different ages, and this alone calls into question stage theorists' proposal that the stages of development are invariant.

Bruner (as cited in Anderson, 1998) said that "To perceive is to categorize, to conceptualize is to categorize, to learn is to form categories, to make decisions is to categorize." It is clear from this statement that Bruner believes that the ability to compare new stimuli with existing structures is critical to learning and development. In fact, the inability to interpret information based on existing mental structures would lead to a failure to adapt higher, more sophisticated mental structures and, hence, to fail to develop cognitively. In regard to this comparison, Bruner's theory suggests that children must develop ways to represent recurrent regularities in their environment. This representation system is developed through the building and establishment of progressively more sophisticated and specific mental schemes or structures (Driscoll, 2000).

To this end, Bruner (1987) recognized three modes of representation that must be present at all stages of development. These three modes of representation (enactive, iconic, and symbolic) are not necessarily hierarchical, but some learning can only be achieved by passing through each type in a specific developmental order. Enactive representation can only demonstrate the past

through appropriate motor experiences. If the enactive mode is the only one being employed, the learner could only demonstrate knowledge by using motor activity to demonstrate thinking. He or she could demonstrate how to do a particular task but could not explain or use any symbolic medium to express knowledge. Iconic representation employs the use of organizational structures, spatial signifiers, or images to represent past experiences. Someone using this type of representation could relate an experience to images or concrete symbols like maps or diagrams. The third mode of representation is symbolic. In this mode, design features that can include remoteness or arbitrariness represent the past. Language is the most common tool used for this type of representation, but the characterizing feature of this type of representation is that the symbols being used do not have to have a concrete correlation to what is being described. The representation goes beyond a concrete connection to the information. It is at this level that analogies could be used to refer to past experiences.

Impacting Classroom Practice

It is important to understand that there is no single set of recommendations as to how to incorporate a constructivistic approach to learning into the classroom. Each of the major theorists has specific recommendations and they do not always agree with each other. The common thread that runs throughout a constructivistic approach is that the development of meaning is more important that the acquisition of a large set of knowledge or skills that are easily forgotten (Black & McClintock, 1995; Moshman, 1982). Two of the most important concepts for applying these theories relate to matching learning experiences to a student's level of readiness and providing for social interaction during the learning process.

Student Readiness

One of the most important considerations to be made in designing instruction from the constructivistic perspective is Dewey's (1944) view that education and schooling should be done for the purpose of preparing the student to live in a democratic society. His advocacy of experiential learning as the basis of the curriculum leads to a set of readiness requirements for those experiences. One of the most important is curiosity or interest in the task to be learned (Dewey, 1998). Students also need to understand the practical applications of the knowledge or skills (Dewey, 1997). A student is therefore ready to learn when the student has the necessary prerequisite experiences that allow him or her to be curious or interested in the learning and to have some understanding about its usefulness.

Piagetian (2001) theory also advocates the importance of the readiness of the student to learn new information. This readiness is based on one of two main factors. Stage theorists hold that the developmental stage or age of the child is the determining factor while interactionalists would argue that it is the child's expertise level (Driscoll, 2000). Regardless of the theory, the result is the same: educators must activate previous experiences, knowledge, and learning strategies in order to effectively present new information in a context that students can readily process.

Although Piaget's framework suggests that students begin moving to the formal operational level in early adolescence (Huitt and Hummel, 1998), data provided by Eylon and Linn (1988) and Renner and others (1976) indicate that most high school students do not reach the formal operational stage and some are still only moving into the concrete operational. Therefore, instructional activities should be structured in such a way as to mediate between

where students are and the cognitive level that schools wish for them to achieve. In addition, from an information processing perspective, students must receive instruction that moves them from the knowledge and comprehension levels of the cognitive taxonomy to the higher levels of evaluation and synthesis (Bloom, Englehart, Furst, Hill, and Krathwohl (1956). This can be done with concrete objects for students in the concrete operations stage and then connected to abstract concepts to help students move to the formal operations stage.

To this end, educators must develop lessons that build from the concrete level to the formal operational level and that require students to use both lower-level and higher-order thinking. This can be consistently achieved if lessons are constructed in such a way that new information draws from previous experience and knowledge and then builds to higher-level thinking. This framework employs a great deal of connection between ideas and activities and requires a great deal of planning to be successful. For example, if at the end of a lesson on satire, one wanted students to be able to pen their own satires, the structure of the lesson might look something like the following.

First, in order to form some connections to concrete interactions and experiences students have previously had, the teacher might bring in examples of comic strips familiar to students. Before talking about any new information - the satire – the teacher might lead a discussion on what makes the comic strips humorous. The examples would be chosen based on their likeness to satire so that the discussion could lead to another concrete tool, the political cartoon. Even though the comic strip and the political cartoon are very similar, the transition is an easy one to make, and the students should be very comfortable. It is highly likely that every child in a high school classroom has seen some type of comic strip, and, hopefully, most would have even been exposed to political cartoons at some point in a government or history class. Vygotsky (1978) would also suggest that student readiness is an important factor in learning, but would emphasize observing how a student works independently and then attempting to teach the student a new concept in order to ascertain the student's "zone of proximal development." All instruction would then take place within this zone.

Once the concrete connection has been established, students must begin making metaphorical connections between the ideas expressed in the cartoons and the intent of the writer. What do you think the writer hoped to gain by creating this cartoon? What might be some other reasons people create cartoons like these? This connection must be made if the students are to understand the motivation behind satire in general, and must be understood if students are later to evaluate and create satires based on their new information on the topic.

Bruner (1990) makes another case for the importance of readiness. He suggests that children need social and cultural experiences that prepare them to understand the meaningfulness of their actions as well as those of others. Bruner distinguishes between behavior, whether mental or physical, and action, which he defines as intentional behavior displayed within a specific cultural setting that includes the reciprocal actions of other participants. Bruner therefore advocates providing children with the kinds of experiences that would allow them to create meaning through their interaction during instructional activities and to assist students in creating that meaning. This then creates the readiness for the next learning experience.

Social Interaction

Dewey's (1944) emphasis on the preparation of children and youth for living in and supporting a democratic society led him to advocate social interaction as a primary source of

instruction. Interactions between adults and children are of primary importance as they are the means of the transmission of culture from one generation to the next. Social communications are a critical feature of a democracy and children must be allowed and encouraged to develop their skills in this area. It is the continuous experience of interacting in groups to achieve a practical purpose that provides the foundation on which these skills develop.

Vygotsky's (1978) theory focuses on the learner's utilization of the signs and symbols of the culture as a basis for knowing. To the extent that his theory is valid, it is imperative that parents and educators provide students with a correct worldview that incorporates valid formulas for success in the adult world. A major problem facing educators and parents today is that the world is rapidly changing and a worldview that propelled our nation to greatness in the 20th century needs to be replaced by one that is more appropriate for the world in which our children and youth will spend their adult lives (Huitt, 1999). One of the most important skills is the ability to get along with a wide variety of people of different backgrounds, ethnicities, personalities, etc. Cooperative learning provides a method for addressing this vital aspect of schooling (e.g., Holt, 1997). At the same time, cooperative learning provides a strategy whereby students can learn from one another.

There are four major components of successful cooperative learning strategies (Huitt, 2002):

1. There must be cooperative interaction among groups. Merely assigning students to groups does not have an impact on students; they must have an opportunity to work together on a project or learning assignment.
2. Group incentives must be provided. This works as a cohesive factor in getting individual students to operate as a group. This also provides an incentive for the more capable students to assist those less capable in the learning process.
3. There must be individual accountability. If only group incentives are provided, it allows some students to do nothing and still earn the group incentive. By holding each individual responsible for his or her work, the teacher can encourage all students to participate.
4. There must be an equal opportunity for all students to earn high scores and contribute to the group effort. This is often done by calculating gain scores as well as absolute scores. For example, if a student scored above 90 on an exam that would contribute 4 points to the group's score. However, a student with a 60 average could also earn 4 points by scoring 10 points above her average. The group would then receive an incentive for obtaining a specific average gain score.

Two additional components of cooperative learning that have been demonstrated to be successful in some situations are task specialization (e.g., Aronson, 2000) and team competition (e.g., Slavin, 1994). While these are not absolutely necessary, their inclusion often adds an important element to the overall success of cooperative learning strategies.

Instructional Example

Desetta and Wolin (2000) provide an excellent example of a constructivistic approach to teaching writing skills. Teenagers who had attended a writing workshop were asked to write stories about their lives with the best selected for publication in one of two magazines for youth (see http://www.youthcomm.org/). A review of the organization's mission statement reveals

many of the principles of a constructivistic approach to learning such as the need to relate learning directly to the individual's life experiences, to provide a realistic audience where students can demonstrate their learning, and to provide opportunities for social interaction during the learning process (Youth Communications, 2004):

- Teens need a public forum for sharing their experiences, exploring the issues that affect their lives, and identifying their common concerns. Our magazines are designed to provide that forum.
- Teens who read little else are more likely to read and heed stories which accurately reflect their experience and concerns. The stories we publish provide a rich source of information and peer perspectives, and influence many teen readers to change their attitudes and behavior.
- For young writers and artists, producing a magazine for their peers is a powerful learning experience. Through a rigorous process that begins by reflecting on their own experiences and place in the world, our students acquire a range of skills and develop the self-awareness necessary to effect change in their lives and in society at large.
- To grow and change, young people need to interact and bond with their peers. We provide an environment in which teens from diverse backgrounds learn to support and respect each other.
- Reading and writing remain the best ways to encourage reflection and discussion, and stimulate the imagination. Literate, thoughtful citizens are essential to the survival of a diverse, democratic society.

For the book, Desetta and Wolin selected writing examples that related to one of the major resiliency themes identified by Wolin and Wolin (1993): insight, independence, relationships, initiative, creativity, humor and morality. The stories can be read by youth, some of whom are not regular readers, to encourage them to be resourceful and struggle to solve their own problems. The book also serves as a guide for educators who are looking for ways to make the communication processes of reading and writing more relevant to their students.

Summary

In summary, it is important to realize there are a variety of recommendations from constructivist theorists as to how instruction should be organized and implemented. These range from Dewey (1991) who proposes that educators should not impose a curriculum on students but rather act as a guide or assistant to Vygotsky (1978) who advocated that teachers provide direct learning experiences to the child as needed. Bruner (1987, 1990), in attempting to synthesize the recommendations of constructivist theorists, suggests that in addition to attending to readiness and social interaction, educators should require students to go beyond the content or information provided and fill in the gaps in their knowledge through exploration and inquiry. This can best be accomplished using a concept he describes as a spiral curriculum, where the same topics are addressed at ever increasing levels of abstractness and complexity. On the surface, this recommendation might look quite similar to one advocated in a standard curriculum. The major difference is that new concepts are introduced by tying them to previous learning rather than their being separate and independent. The practical implication of this approach is that fewer concepts are covered, but the ones that are covered are explored in greater depth.

Assessment and Evaluation

There are number of implications for how to assess cognitive development using the perspective of the stage-theory models of Piaget and Bruner. First, these models of development contend that growth occurs in serial, sequential manner and that developmental stages are biologically driven and correlate to a specific range of ages. If these theories are correct, assessment should take into account what is developmentally appropriate to each stage. With the ever-increasing pressure to raise standards and expect higher-level processing, how students are assessed is of critical importance, and stage-theories create conflict between what can and should be taught. Some researchers argue that it is pointless to present certain types of information to learners at developmentally inappropriate levels and that attempted assessment of higher-level thinking skills is pointless. Orlich (2000) says, "One could argue, as many naïve reformers do, that American students just don't work hard enough.... It will do little good to make 9- and 10-year-olds work harder if their cognitive development has not reached the level that allows them to engage in formal operational thinking" (p. 4).

In contrast, children of all ages show information processing skills at all levels of the cognitive taxonomy developed by Bloom et al. (1956), though certainly maturational factors play a role in the complexity of their use. For example, children acquiring their first language exhibit the natural ability to use analogies between the ages of 3 and 4. When a 3-1/2- year-old inappropriately uses a phrase like "I goed to my bedroom," she is using application and analogy skills. Although no one has explicitly explained the grammatical rule of creating past tense forms, she has analyzed that one typically uses an –ed suffix to indicate a past action. In addition, she has made the assumption, albeit incorrectly, that, in order to express the past action of going, she would apply the same rule. One could even argue that her production of this new form exhibits synthesis level thinking because she has integrated the rule and created a new speech pattern. At the very least, she has gone through the computational model's first three stages: observation/experience, generalization, and rule formation.

However contradictory these ideas may seem, many researchers believe that developmental stages must be considered in assessment. In order to appropriately assess the pre-operational child, activities must be based on the physical environment and focus on hands-on interaction. The egocentric nature of the pre-operational child suggests that activities and assessments should be limited to the personal perspective of the individual, and the pre-operational child will probably be unable to take into account the opinion or perspective of others. Green and Gredler (2002) suggest that, in accordance with Piagetian theory, "the material world should be the starting point for learning because it is both accessible and contains complexities of which children have never dreamed" (p. 3).

Once a child has reached Piaget's third stage, concrete operations, the assessments should be vastly different. At this point in development, students can recognize and evaluate the views of others. This alone adds great dimension to the types of assessments that would be appropriate because students can now be asked to evaluate and critique differing viewpoints and discuss perspectives other than their own. Another attribute of the concrete operational child is that he or she can participate in logical reasoning and use symbolic representations to solve problems using operations, applications, and generalizations. There are limitations to this stage as well. The major limitation of children in the concrete operational stage is the inability to think hypothetically (Driscoll, 2000), and they continue to have difficulty solving problems that are multi-faceted. Understanding and appropriately assessing this developmental stage is critical for educators

because “the majority of students in middle schools and high schools are still in the concrete operational stage” (Orlich, 2000, p. 3).

When a student reaches the formal operational stage, the range of assessments is almost endless. These young people can now employ the use of analogies and hypotheses in problem solving, and they can incorporate value judgments and problems of social and cultural scope as part of their processing.

While considering a child’s current developmental stage is important in creating appropriate assessments, it is important at all levels to continue to have students use skills and information processing techniques from all previous developmental stages in the acquisition of new information. Assessments at every stage should also be concerned with all previous stages. This is crucial because “if individuals maintain access to preceding stages of cognitive ability, a pattern of seemingly lower level responses may be an integral part of processing new information and developing abilities beyond their current optimal level” (Stanton, 1993, p. 3).

A second major group of developmental theories is associated with interactive theories of development, primarily those of Dewey (1991) and Vygotsky (1978). These ideas focus on the development of the child in relation to their social interactions. The key element of assessment for this school of thought is that it should be done in a socially context-rich environment. Suizzo (2000) says, “a child’s performance level on a given cognitive task will vary according to the level of social support he or she is accorded” (p. 846). This possible variance suggests that for assessments to be valid, they must be conducted in a socially supportive setting because “With modeling or memory prompting by an adult, children will be able to perform at their optimal level, but without that support, they may perform only at their ‘functional’ level and show no evidence of competence at the higher level” (Suizzo, 2000, p. 846).

A significant principle of John Dewey’s (1944) theory is that assessments and evaluations should be done in the context of practical, real-world applications of knowledge, dispositions, and skills. If possible, learning should result in products that would be recognized as useful by the society. For Dewey, traditional assessments that rely on measuring a student’s knowledge or skills outside of the context within which they would be used misrepresent what the student knows as knowing is equated with doing.

Summary and Conclusions

In summary, the work of Dewey, Piaget, Vygotsky, and Bruner present a powerful case that human beings seek meaningful interactions with the environment and construct knowledge of themselves and the world around them through these interactions. Collectively, these theorists provide the foundation for an approach to learning called constructivism (Schunk, 2000). Moshman (1982) suggests there are three competing forms of constructivism: exogenous, endogenous, and dialectical. Those subscribing to an exogenous viewpoint are heavily influenced by Vygotsky (1978) who proposes that the individual first adopts social and cultural artifacts and then adapts these to his own knowledge structures. Those more oriented to the endogenous viewpoint are more influenced by Piaget (2001) who proposes that knowledge structures come first and guide one’s interaction with the environment. The dialectical position purports that both are correct (as well as incorrect): knowledge and cognitive processing competencies derive from the interaction of the individual and environment. However, they would not subscribe to the position that all knowledge is inextricably tied to specific environments nor are specific structural capacities necessary for learning to occur. Bruner (1987) and Dewey (1998), as well as Bandura (1986), are examples of researchers who would support this perspective.

Brooks and Brooks (2000) state there are at least four guiding principles for educators and parents who desire to put a constructivistic viewpoint into practice. First, because learning is a search for meaning, learning objectives should be established that connect to issues important to the student. These issues might arise from biology and maturation, one's sociocultural environment, or some combination of both. The precise origin is less important than the fact that the individual perceives some meaning in the learning task. Sometimes educators will need to place students in situations that will create disequilibrium or curiosity in the learner before beginning a learning task. Other times the learner will come to the task with a set of questions that he or she wants answered. In either case, to begin a learning task without establishing that the student perceives a "need to know" what is being taught will produce frustration on the part of both teacher and student and little learning.

A second principle of constructivism is that meaningful learning requires an understanding of wholes as well as parts. To constructivists, the inductive approach advocated by behaviorists whereby pieces of a process are taught separately and then combined into a complete process is the opposite of a sound instructional process (Ertmer & Newby, 1993). A constructivistic process involves having the student engage in the complete process, first in a simplified manner and then in more complex ways (e.g., the spiral curriculum process advocated by Bruner, 1977). For example, students would engage in the process of writing by first writing sentences, then simple paragraphs, then more complex paragraphs, etc. Correct punctuation, parts of speech, spelling and other specifics would be taught as they were needed to complete these holistic tasks.

A third principle discussed by Brooks and Brooks (2000) is that educators must understand students' mental models or representations of the world in order to help them learn and integrate new understandings. To a constructivist, learning is the process of adjusting mental models to better adapt to the world around us. As previously discussed, these models can be impacted by our biology and our experiences. It is not enough to understand these principles in general; we must understand each individual's mental model if we are to successfully guide learning. That requires that we become intimately involved with learners in the teaching/learning process. It also means that we must provide ample opportunities for students to demonstrate and/or express their mental models, preferably in the process of learning rather than in a high-stakes testing environment. This is difficult, if not impossible, to do in a standardized curriculum and implies that teachers must provide different kinds of learning experiences for students based on their mental models.

This then leads to a fourth principle of the constructivistic approach. Assessment, measurement, and evaluation should be a natural part of the learning process rather than an activity completed at the end of the learning process. The focus is on the use of projects and portfolios as means of demonstrating competence rather than tests given at the end of a unit, semester or year. Additionally, students should be involved in making judgments of learning and these judgments should be combined with judgments of teachers or other experts when making decisions about grades.

While there are a variety of viewpoints as to the viability of constructivistic methods (Phillips, 2000), there is little doubt that this approach is gaining in popularity (Marlowe & Page, 1998). What is currently needed is more work on both the validity of specific components or principles as well as methods of documentation that can accurately describe the benefits of this approach to student learning. Many principles of learning from the behavioristic and cognitive paradigms have proven quite valuable (Cooper, 1993; Ertmer & Newby, 1993) and should not be completely abandoned in a continuing search for better methods of guiding student learning.

References

Anderson, M. (1998). Jerome Bruner. *Educational Psychology*. Portland, OR: Cortland College. Retrieved June 2002, from http://facultyweb.cortland.edu/~andersmd/cog/brunder.html

Aronson, E. (2000). *Nobody left to hate: Teaching compassion after Columbine*. New York: W. H. Freeman.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Black, J., & McClintock, R. (1995). An interpretation construction approach to constructivist design. In B. Wilson (Ed.), Constructivist learning environments. Englewood Cliffs, NJ: Educational Technology Publications. Retrieved February 2004, from http://www.ilt.columbia.edu/publications/papers/icon.html

Bloom, B., Englehart, M., Furst, W., Hill, W., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain*. Boston, MA: Addison-Wesley.

Brooks, J., & Brooks, M. (2000). *In search of understanding: The case for constructivist classrooms*. Upper Saddle River, NJ: Prentice-Hall.

Bruner, J. (1977). *The process of education*. Cambridge, MA: Harvard University Press. [Originally published in 1960].

Bruner, J. (1987). *Actual minds, possible worlds*. Cambridge, MA: Harvard University

Press. Bruner, J. (1990). *Acts of meaning*. Cambridge, MA: Harvard University Press.

Case, R. (1985). *Intellectual development: Birth to adulthood*. San Diego, CA: Academic Press.

Cole, M., & Wertsch, J. (1996). Beyond the individual-social antimony in discussions of Piaget and Vygotsky. *The Virtual Faculty*. Palmerston North, New Zealand. Massey University, Retrieved July, 2002, from http://www.massey.ac.nz/~alock//virtual/colevyg.htm

Cooper, P.A., (1993, May). Paradigm shifts in designed instruction: From behaviorism to cognitivism to constructivism. *Educational Technology, 33*(5), 12-19.

Desetta, A., & Wolin, S. (Eds.). (2000). *The struggle to be strong: True stories by teens about overcoming tough times*. Minneapolis, MN: Free Spirit Publishing

Dewey, J. (1944). *Democracy and education*. New York: Macmillan. Retrieved August 2002, from http://www.ilt.columbia.edu/publications/dewey.html. [Originally published in 1916].

Dewey, J. (1991). *School and society* and *The child and the curriculum* (Reissue edition). Chicago: University of Chicago Press. [Originally published in 1896 and 1902].

Dewey, J. (1997). *Experience and education*. New York: Macmillan. [Originally published in 1938].

Dewey, J. (1998). *How we think* (Rev. ed.). Boston, MA: Houghton Mifflin Company. [Originally published in 1933].

Driscoll, M. (2001). *Psychology of Learning for Assessment* (2nd ed). Boston: Allyn and Bacon.

Ertmer, P., & Newby, T. (1993). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly, 6*(4), 50-72.

Eylon, B., & Linn, M. (1988). Learning and instruction: An examination of four research perspectives in science education. *Review of Educational Research, 58*(3), 251–301.

Flavell, J. (1963). *The developmental psychology of Jean Piaget*. New York: D. Van Nostrand.

Flavell, J., Miller, P., & Miller, S. (2002). *Cognitive development* (4th ed.). Upper Saddle River, NJ: Prentice-Hall.

Galant, M. (1998). Vygotsky's cultural/cognitive theory of development. *Educational Psychology*. Portland, OR: Cortland College. Retrieved June 2002, from http://facultyweb.cortland.edu/~ANDERSMD/VYG/VYG.HTML

Green, S., & Gredler, M. (2002). A review and analysis of constructivism for school-based practice. *School Psychology Review, 31*(1), 53-69.

Greeno, J. (1989). A perspective on thinking. *American Psychologist, 44*, 134-141.

Holt, D. (1997, October 15). *Cooperative learning: Response to diversity.* Sacramento: California Department of Education. Retrieved August 2002, from http://www.cde.ca.gov/iasa/cooplrng.html

Huitt, W. (1999). Success in the information age: A paradigm shift. *Educational Psychology Interactive*. Valdosta, GA: Valdosta State University. Retrieved August 2002, from http://chiron.valdosta.edu/whuitt/col/context/infoage.html

Huitt, W. (2002). The information processing approach. *Educational Psychology Interactive*. Valdosta, GA: Valdosta State University. Retrieved June 2002, from http://chiron.valdosta.edu/whuitt/col/cogsys/infoproc.html

Huitt, W. (2003). A systems model of human behavior. *Educational Psychology Interactive*. Valdosta, GA: Valdosta State University. Retrieved June 2002, from http://chiron.valdosta.edu/whuitt/materials/sysmdlo.html

Huitt, W., & Hummel, J. (1996). Cognitive development. *Educational Psychology Interactive*. Valdosta, GA: Valdosta State University. Retrieved June 2002, from http://chiron.valdosta.edu/whuitt/col/cogsys/infoproc.html

Kearsley, G. (2001a). Constructivist theory. *Theory Into Practice.* Jacksonville, FL: Jacksonville State University. Retrieved July 2002, from http://tip.psychology.org/bruner.html

Kearsley, G. (2001b). Social development theory. *Theory Into Practice.* Jacksonville, FL: Jacksonville State University. Retrieved July 2002, from http://tip.psychology.org/vygotsky.html

Marlowe, B., & Page, M. (1998). *Creating and sustaining the constructivistic classroom*. Thousand Oaks, CA: Corwin Press.

Moshman, D. (1982). Exogenous, endogenous, and dialectical constructivism. *Developmental Review, 2*, 371-384.

Nicholl, T. (1998). Vygotsky. *The virtual faculty*. Palmerston North, New Zealand. Massey University, Retrieved June 2002, from http://www.massey.ac.nz/~alock//virtual/trishvyg.htm

Orlich, D. (2000). Education reform and limits to student achievement. *Phi Delta Kappan, 81*(6), 468.

Parent, S., Normandeau, S., & Larivee, S. (2000). A quest for the holy grail in the new millennium: in search of a unified theory of cognitive development. *Child Development, 71*(4), 860-861.

Phillips, D. (Ed.). (2000). *Constructivism in education: Opinions and second opinions on controversial issues*. Chicago, IL: The National Study for the Study of Education.

Piaget, J. (2001). *The psychology of intelligence* (2nd Ed.). London: Routledge. [Originally published in 1950].

Renner and others (1976). *Research, teaching, and learning with the Piaget model*. Norman, OK: University of Oklahoma Press.

Schunck, D. (2000). *Learning theories: An educational perspective* (2nd ed.). Upper Saddle River, NJ: Merrill.

Siegler, R. (1991). *Children's thinking* (2nd ed.). Upper Saddle River, NJ: Prentice-Hall.

Slavin, R. (1994). *Cooperative learning: Theory, research, and practice* (2nd ed.). Boston: Allyn & Bacon.

Stanton, W. (1993). A cognitive development framework. *Current Psychology, 12*(1), 26-47.

Suizzo, M.A. (2000, July/August). The social-emotional and cultural contexts of cognitive development: Neo-Piagetian perspectives. *Child development, 71*(4), 846-849.

Vanderstraeten, R. & Biesta, G. (1998). *Constructivism, educational research, and John Dewey*. Paper presented at the Twentieth World Congress of Philosophy, Boston, August 10-15. Retrieved March 2004, from http://www.bu.edu/wcp/Papers/Amer/AmerVand.htm

Vygotsky, L. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wink, J., & Putney, L. (2002). *A vision of Vygotsky*. Boston: Allyn & Bacon.

Wolin, S. J., & Wolin, S. (1993). *The resilient self: How survivors of troubled families rise above adversity*. New York: Villard.

Youth Communication. (2004). *Who we are: Youth Communication mission statement*. New York: Author. Retrieved March 2004, from http://www.youthcomm.org/WhoWeAre/Mission-Statement.html