

## Chapter 2

# How Development Affects Learning: Lessons Learned from Developmental, Cognitive, and Natural Science

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Much attention has been paid to the “education crisis” arising from the gap between students needs and expectations and the lack of resources available to teachers and schools to address those needs. Federal initiatives such as the No Child Left Behind Act (NCLB), The Individuals with Disabilities Education Improvement Act (widely known from previous authorizations as IDEA), and other phenomena exert crushing demands on the current model. With these changes, terms such as inclusion, accountability, and mastery have become part of the everyday nomenclature in schools. As communities struggle to meet the needs of learners, new support for learning is developing. Today, programming extends beyond the school day to include before- and after-school, as well as home- and community-based settings for many children. After-school programs, in particular, play a vital role in increasing the academic success and social competence of young learners.

Creating learning programs that effectively increase student mastery of skills is vital. Merging what is known about the development of young children and effective instructional design practices can create effective and efficient educational programs. This current chapter examines the development of young children by extracting themes that can guide the implementation of effective after-school programming for young learners.

## Defining Learning and Development

Parents, teachers, peers, and mentors support children as they face the challenges of development. Much is known about the typical scope and sequence of development (i.e., growth trajectories). For example, we know

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that patterns of learning are individual. Each child progresses at a different rate, is drawn to different subjects, and is motivated by different events. Trends emerge across similar groups of learners. Thus, we may ask, “what develops?” in the learner, and “under what conditions does development occur?” (Novak, 1996, p. 268). Knowing the answers to these questions permits the creation of educational programs that maximize this growth. To answer these questions, we must examine what is meant by learning and development. There are different ways in which a skill can be acquired, different depths or quality of that learning, and different means of making experiences available to the learner. For each event to be taught, the best way to provide instruction to complement and facilitate development should be considered.

### ***What It Means to Learn***

Learning is a relatively permanent change in behavior that occurs over time as a result of experience. A complex interplay of both biological and environmental factors influence what is learned, how, and when. Some learned events have a primarily genetic character (and etiology, or cause) and are shared by most members of that group, whereas other events are more influenced by unique experiences that occur during the life of a particular learner. Developmentalists often refer to the contribution of *nature* as the constellation of biological patterns that are present at birth and to *nurture* as the impact of events that the child encounters as they experience their world. An additional means of learning is often identified as culture because of its role in transmitting information through such shared practices as language, beliefs, and traditions.

### ***Learning Through Consequences***

As a youngster interacts with the world, new skills and repertoires can be established in at least two ways: through the outcomes of a learning event or through associations with what is already known. Knowing the processes by which each type of learning occurs allows educators to arrange instruction in ways that facilitate these events.

When a learning event occurs and produces a particular outcome, that outcome can make the event more or less likely to be repeated in future settings. Favorable outcomes, from the perspective of the learner, make a learning event more likely to be repeated than events followed by unfavorable outcomes. These outcomes of learning are called consequences. Learning through the impact of consequences forms the science of operant conditioning.

It is important to note that by consequences, we do not mean the popular interpretation of the term as “bad things happening”; we simply are examining

what occurs as a result of the learner's interaction with their world. Consider this example: If a teenager bullies a peer, the outcome of this interaction may be complex. It may include immediate feelings of power, later feelings of guilt, immediate increases in peer standing in some groups, immediate decreases in prestige with other groups, legal penalties, receiving a desired item (i.e., the peer's lunch money), avoiding class (by being sent to the principal's office), having more work to do later, parental penalties, a rush of adrenaline, and more. Whether the teen repeats this event or not is a function of the outcomes that are most powerful to that individual and how often they are produced. If an increase in peer standing with their target peer group is the most important outcome for the teen at that moment, then the teen might bully again. This outcome may even overshadow the effect of other sanctions, even if they were unfavorable. The learner will respond most to the outcome that is most powerful to them at that time. We develop a history of receiving certain consequences for certain behaviors and that shapes our choices about what to do (or not do) later on.

When examining the impact of consequences for behavior, we must take the perspective of the learner and be aware that the same learner may be impacted differently by the same outcome at different times or in different settings. This is because each learning event changes the learner in ways that effect subsequent interactions. Additionally, the context may have an impact on the value of an event to the learner. For example, getting a high mark on a paper might be motivating for a teenager if they can show it to an important mentor but might be uncomfortable if they are required to share it with their peer group. The context changes the value of the outcome for the learner.

The most valuable consequence to understand and use in teaching and learning environments is the reinforcer. A reinforcer is an event that when it is presented after a behavior increases the likelihood of the learner performing that action again. Reinforcers are events or circumstances that are favorable to the learner. All learners have unique preferences that will change and evolve over time. Some favorable outcomes include adding an event to the learner's environment and some include removing an event from their environment. These arrangements are called positive reinforcement and negative reinforcement, respectively. In both cases, the resulting situations must be something that learner prefers. When a peer group finishes their work accurately and rapidly, they may be provided with the opportunity to play a computer learning game as a reinforcing consequence that is added after homework completion. Conversely, altering something they dislike, like waiting in the long lunch line, removes a nonpreferred state and serves to reinforce behavior also. In both cases, it is important to stress that behavior happens more often because the learner's behavior is followed by a has a favorable outcome.

By arranging for favorable outcomes after the learner's behavior, educators can increase the performance of important skills. Helping learners to develop

the capacity of self-feedback and to deliver their own reinforcers is an important goal for educators and has a powerful and lasting effect on student learning.

Although other types of consequences are available (see Fitzgerald & Walker [2005] for a review), their effect is to decrease behavior, rather than to increase it as reinforcement does. In academic settings, increasing appropriate skills is the priority. Behavior management programs should focus on maximizing the learner's success by engaging them in appropriate skills by all positive means available.

### ***Learning Through Associations***

Learning occurs when a new event becomes associated with something with which the learner already has some knowledge. For example, Grandma is wonderful and apple pie is more wonderful because she makes it every time I see her. In this case, what I know about one event (Grandma) becomes associated or interwoven with what I know about another event (apple pie). Preschools use this effect to increase children's positive associations between the school setting and learning new skills. This is done by pairing fun and exciting learning activities and the school itself. However, it is important to note that school phobias can be acquired in the same manner. When such experiences as academic failure or peer rejection occur in school settings, a student may come to associate school with unfavorable events.

In this type of learning, it is not the outcome of an event, but the pairing of one event with another that establishes whether it will be repeated. When two events are paired often, or intensely, they are more likely to be repeated. These associations form the science of respondent conditioning. Learning based on respondent conditioning includes both simple associations and more complex events. Because such variables as the setting, individuals, and activities that are present during a learning event can become associated with strong feelings for the learner, educators should be careful to arrange associations that contribute positively to a learner's motivation and development.

### ***Types and Depth of Knowledge***

Learning changes the individual; in fact, all of the repertoires of the learner are affected by changes in each skill. The individual approaches similar situations anew after a learning event has occurred. For example, a child who is bitten by a dog may come to speak about and approach dogs differently, and may even come to, dream of dogs, hear dogs, and feel dogs in ways different than before the biting event. Some measures of learning from this experience are more biological in nature, such as the increased sensitivity to the sound of a dog

bark; some measures are more environmental in nature, such as the changes in proximity to the dog; while still other measures of this experience can be said to be behavioral, such as the changes in thinking about dogs that the child experiences. Even an individual who reports no fear may be relaying subtle postural, hormonal, or respiratory changes that could indicate fear. Learning affects the whole of the organism as well as the way that it interacts with its environment even if we are not consciously aware of these effects.

We have seen that there are at least two different processes by which learning can be acquired. Once a skill has been acquired, it can be further described by the depth or level of knowledge demonstrated. According to Bloom (1956), there are six levels of knowledge that describe most learning. The first level is direct knowledge, which is closely related to the instructional material. A spelling test is a good example of this type of knowledge where the goal is to learn the correct order of letters that compose specified words. A second level of knowledge is comprehension. Here the learner is expected to generate an independent answer that represents his or her own analysis. Having a classmate answer questions about what new initiatives a candidate for class president would support after hearing his or her campaign speech illustrates the student's comprehension of the speech. Application is the next level of knowledge whereby the student is expected to use some previously acquired piece of information to solve a problem in a new setting. For example, if a child is taught to spell words in school using certain rules of speech and then is asked to spell the names of items in their home for homework, then they would be applying their knowledge. A fourth level of knowledge is analysis. Analysis requires breaking a concept into its component parts. One then makes comparisons between concepts such as the similarities and differences between healthy and unhealthy foods. Synthesis, a fifth level of knowledge, is the integration of separate component skills to form a composite skill. This may occur, for example, when a learner combines basic repertoires in problem solving, addition, subtraction, multiplication, and division in the completion of an advanced algebra problem. The final level of knowledge is evaluation. This requires the use of previous levels of knowledge as the learner offers arguments in favor of or against a particular position, event, or decision, as when they consider, for example, which college to attend and why. These levels of knowledge are useful for educators, as Engelmann and Carnine (1991) and others have emphasized matching learning objectives and the teaching methods used to attain them to the different levels of knowledge that might be obtained.

The quality or depth of learning also can be measured in terms of the fluency of the skill. Fluency is a measure that identifies that the skill meets a level of mastery like that of an expert's performance in that it is both rapid and accurate (Binder, 1996). This scientific concept maps directly onto the everyday use of the term *fluency* when describing one's skill in a language. There are two important dimensions of fluency: accuracy and rate. First, an expert performance must be correct, or meet some standard for appropriateness.

In the case of language, this would mean using the right words and understanding those used by others in conversation. The second dimension of fluency differentiates it from measures of the acquisition of a skill by examining the rate at which the skill can be performed. The pace or speed at which an accurate performance can be exhibited is a noteworthy part of expert performances. When you are newly acquiring a second language, think of how fast it seems that fluent members speak. You might also think of the rate dimension of fluency as the tip of the tongue phenomenon, in that what is well-known is also so readily accessible it is as if it were on the tip of your tongue. To demonstrate the concept of fluency, we might consider the case of two students in the same mathematics class. A student who can complete 100 long division problems without any errors in 1 hour is accurate, but the peer who can complete the same 100 problems correctly in 20 minutes or less shows a higher level of mastery. An accountant may perform this skill faster still. The performance that most closely matches that of an expert is the one that is considered fluent. Thus, the second student is said to have a higher level of mastery than the first but still less mastery than an expert (the accountant). Fluency is an excellent measure of mastery after we have determined that a skill has been acquired (Kubina & Morrison, 2000). Fluency is especially effective as a measure of mastery in academic settings because it has been shown to produce increases in the retention of skills, endurance on a challenging task, and application to new settings while maintaining high standards for the quality of the skill (Johnson & Street, 2004).

### *Intentional Versus Incidental Learning*

Some learning events are specifically arranged and others occur in the course of everyday experiences. Specifically, arranged learning is called intentional, programmed, or structured. These experiences constitute the bulk of a child's academic life, most parenting efforts, and many cultural experiences. The curriculum for third grade, for example, provides a list of learning events that the teacher should ensure the student is exposed to and obtains mastery of before entering the fourth grade. Similarly, parents give children household responsibilities to prepare them for life as independent adults, and cultural communities involve youth members in important events to teach them traditions to pass along to yet future generations.

In contrast, learning that occurs naturally, or incidentally in everyday experience, is not specifically arranged. This might include learning how to make friends in new places and problem-solving strategies that work best for one's learning style. Although trends in education may sway toward or away from a particular way of providing learning experiences, the science of learning shows that effective instructional practices are applied in both intentional and incidental learning environments (Moran & Malott, 2004). A match between

the skills of the learner and the goals of the teaching event should dictate the way that learning is arranged to maximize student success. In fact, failure to facilitate this match in the design of learning experiences can put a learner at a distinct disadvantage. Consider the following example of incidental or naturally occurring versus intentional or programmed instruction. The Greek scholar Pythagoras and the modern inventor Einstein are examples of individuals who pursued their interest in events and accomplished significant depth of knowledge in their fields by learning from natural experimentation. They acquired their knowledge in a timely manner and developed additional skills simultaneously and at a relatively young age. However, these individuals represent the exception, rather than the rule. Most individuals require extensive well-designed instruction to understand the advances in geometry and physics (to name just a few areas) that these individuals brought about.

Thus, given that the majority of our instructional experiences are programmed, the question of how best to let the learner navigate these events is important. The level of instructional support for a learning event must be a function of variables involving the learner, teacher, subject matter, and setting. There is never one method that will match all situations. The educator must choose the best fit for their program at that time and then modify instruction as variables change. The continuum of instructional support ranges from experiences that allow the learner to experiment with the environment and are grounded in trial-and-error discovery to structured teaching programs that guide the learner to correct responses through errorless learning. Consider this contrast in a familiar educational task. In the Piagetian conservation task where two glasses of different shapes containing an equal volume of liquid are presented to young learners who are then asked to determine which one contains the most liquid, different levels of instructional support could be arranged. A trial-and-error approach may evoke an answer from the learner and be followed with feedback on the accuracy of their choice. In contrast, an approach that uses errorless teaching techniques would prearrange a number of instructional tasks that would guide the learner's responding toward the correct answer (i.e., they are equal) and away from other choices (i.e., the tall, thin glass contains more, or the short, broad glass contains more). Research shows that each approach has benefits and shortcomings (Fitzgerald, 1997). Specifically, trial-and-error learning can produce strong, lasting knowledge that is flexibly paired with new information, but learning this way is time consuming, frustrating, and frequently leads to burnout, or even dropping-out of that task and related experiences. Errorless learning is efficient and effective at establishing knowledge and enthusiasm for learning, yet information may not be remembered as long or as readily expanded upon as that which is learned with some errors. Again, we are reminded that learning is individual and fluid and must be paired with teaching that shares these qualities to most effectively bring the learner to the desired outcome.

## *Learning and Development*

Development flows from learning. We see development in the progressive changes that a learner makes along one dimension or skill over time. These changes can be tracked and trends in learning can be identified. The development of trends may be a slow process. For example, a learner may display a skill once, then not again for an extended length of time. The skill is seen again, and followed by successively more and more instances of the skill. Once it is reliably observed in a given setting, then we can speak of the skill as acquired. As particular groups of skills come together to create more complex patterns of behavior, we can speak of these patterns as development.

Progressive changes in the nature of interactions between the learner and their environment are what we examine when we refer to development (Bijou & Ribes, 1996). Children develop, not merely because of the passage of time, but because particular meaningful experiences are had at important times. Timing is important because a child must be ready, that is they possess the necessary prerequisite component skills and abilities (also referred to as foundation skills), to take advantage of this new experience. In fact, it may be that much of what we call development depends on the organization and sequence of teaching practices in a given social or cultural setting (Rosales-Ruiz & Baer, 1996).

Development has distinct characteristics (Novak, 1996). First, it is a process that is dynamic. The learner is ever changing, each new experience creating a new perceptive. Once children master the skill of walking, for example, they solve problems of mobility and negotiate physical challenges in vastly different ways than they did as crawlers, and this repertoire continues to evolve. Second, development, though progressive, is nonlinear and may occur in spurts and leaps. This varying pace and, sometimes, sequence of developmental events is observed in the case of identical twins reared together advancing through different skills at different times. Third, action is required for development to unfold. That is, there is interdependency between young children and their environment. This is illustrated by the young learner who is read to and exposed to the written word at an early age mastering the skill of reading at a developmentally appropriate age, and the child who is not exposed to a world rich with books struggling with reading. Additionally, development is reciprocal. Events change the learner, but are changed also by the youngster as they navigate their environment. This dance is ongoing. The reciprocal nature of development is seen clearly in the observation of a teacher and a child during imaginative play as they take turns in creating a game or scripting the exchange of characters, each interaction feeding off of that before it. Most importantly, development is malleable. The outcome of a child's development is not pre-written and is subject to the influences – beneficial or detrimental – of their ongoing experiences. For educators, this malleability provides a call to service as teaching changes developmental outcomes.

## ***Developmentally Appropriate Practice***

Developmentally appropriate practice provides meaningful experiences at the optimal time so that the learner can move to the next step with other supports in their environment. There is a fine balance to negotiate between the needs of a class of students as a whole, the need to press on to new and more complex experiences for some learners, and the need to engage a single learner in different or additional contact with instruction to bring about their mastery of the material. Because developmental outcomes are strongly influenced by experiences, children have critical periods for teaching and learning that must be facilitated in many ways.

The challenges of development for children in the 5- to 13-year-old populations are vast. The supports for their development should be rich and varied. The developmental challenges that younger children face include transition to full-day schooling, discovering how more complex things work, cooperating with others on task, developing imaginative play, acquiring symbolic language, developing fine and gross motor skills, and increasing pragmatism. Middle childhood brings the following challenges and achievements: the use of logic, discovering patterns, increasing memory, more reliable metacognition, expanding language skills, sense of responsibility, and pride in one's accomplishments. Early adolescence finds the child facing: puberty, identity formation, abstract thinking, scientific reasoning, the importance of peers, moral development, intensification of relationships, and establishing independence from parents.

Instructional environments should integrate practice with appropriate skills in each of these domains. For some children, educational settings may provide their only exposure to vital areas of skill development.

### **Using Developmentally Appropriate Practice to Help Children Catch Up**

Hart and Risley (1995) provided an elegant demonstration of the importance of early environmental supports for learning in their longitudinal study of the language development of young children and patterns of language used by parents from professional families, working-class families, and families receiving welfare. Their robust finding was that the language development, intelligence, and academic success of young children were related to the amount and nature of verbal interactions with their caregivers. Parents in professional families were more likely to provide ongoing descriptive narration of the child's behavior and positive statements to the child than were parents of families receiving welfare. Parents in families receiving welfare had the lowest overall frequency of verbal interactions with their children and the highest percentage of those interactions containing negative statements (e.g., "stop touching that") as compared with positive (e.g., "yes, you said 'top'") or neutral (e.g., "that is a blue car") statements. This early interaction was related to differences in the

child's vocabulary development such that by the age of 3 years, children from professional families had vocabularies that were more than 3 times greater than those from families receiving welfare.

### ***Contributions of After-School Programs to Development***

We know that appropriate experiences are essential for effective development. As a result, many after-school programs are designed to address the cumulative disadvantage that some children experience. Two types of added experience that are used to supplement the development of children are enrichment and acceleration programs. Enrichment programs aim to provide meaningful experiences that may not be available to the learner through standard sources. Such programs may provide access to technology (computers), culture (museums, zoos, theater), leadership (mentoring, professional partnerships), and science (equipment, experiments). In contrast, acceleration programs provide additional contact with increasingly advanced curricular objectives for the student from their current academic placement. This translates to additional time for instruction on the learning objectives already in place for that student and more time to master the curriculum. Depending on the current pace of the learner, this could mean that they work ahead (as in many programs for gifted individuals), or this could mean that they catch up and are able to demonstrate true mastery of the subject matter at a pace similar to that of their peers. Whether based on a remediation, acceleration, enrichment, or another model, after-school programs have the benefit of providing additional time for learning beyond that of the regular school day.

### **Individualization in After-School Programming**

After-school programs have the added benefit of being readily individualized to meet the differing needs of students. After-school programs have been designed as models to guide other implementations, and they have been used to test applications of innovative programs. Many programs have demonstrated positive effects on the development of participants. Such areas as adjustment to elementary education (Posner & Vandell, 1999), academic success (Zosky & Crawford, 2003), and increases in reading skills (Fleming, 2005) have been demonstrated as outcomes of effective after-school programming.

A population that has received great attention in after-school programs is children identified as at-risk for academic failure and other negative social outcomes. In fact, after-school programs have been effective in facilitating the development of children placed at-risk (Riggs & Greenberg, 2004). After-school programs provide an opportunity to follow through on the enrichment that children at-risk need and thus maintain the early gains that these programs

create. This is particularly significant given the finding that to sustain the benefits of programs, such as Head Start and Early Start, they should be continued in age-appropriate ways (Watkins, 1997; Reynolds, 2003).

The benefits of after-school programs also extend to gifted youth. Well-designed acceleration programs, in particular, are effective and appropriate ways of maximizing the abilities of youth identified as gifted (Swiatek & Benbow, 1991). Schools can expand their offerings for gifted youth by offering additional programming in an after-school format.

Although after-school services may be one way to stimulate advanced students, such programs are also useful in servicing students who are members of special populations. Children with emotional and behavioral disorders, in particular, need structured teaching, peer support, and help developing appropriate skills (Wagner et al., 2006). Because these students are academically challenged, after-school programs provide an opportunity for focusing on the acquisition, maintenance, and generalization of skills in effective teaching settings.

Participants in after-school programs who show typical patterns of development can benefit from a curriculum that enhances readiness for the next grade or level of learning.

Programs also function to create cohorts of learners and similarly situated families. Building community bonds benefits both learners (Jackson & Riessman, 2001) and their families. Families with more positive social networks have lower levels of stress and can better meet the needs of their children (Valiente, Fabes, & Eisenberg, 2004; Raikes & Thompson, 2005).

## **Facilitating Learning**

After-school programs that produce the greatest outcomes are guided by practices with demonstrated effectiveness (National Institute of Child Health and Human Development Early Child Care Research Network, 2004). Science is guided by both empirical research and theories of development. By examining common developmental theories and the science that evolves from them, educators can make informed decisions about program adoption. As such, the contributions of developmental, cognitive, and natural science will be examined, and theories, principles, and practices that follow from them will be detailed.

## ***Lessons Learned from Developmental Science***

Developmental science is the scientific, multidisciplinary study of development across the life span with an interest in socially relevant issues (Heatherington, 1998). It looks directly at issues facing youth such as poverty, crime, risk, resilience, divorce, and the media. Developmental science seeks to address

trends affecting different groups of learners, such as those at-risk for academic failure, children of divorce, inner city youth, immigrants, and others.

Developmental science frequently has been at the forefront of emerging prevention programs, especially those that coordinate the talents of a variety of disciplines. Programs such as Early Start and Head Start are examples of prevention programs that in their design embody the values of developmental science. Both programs provide developmentally appropriate programming and address the needs of children labeled at-risk for a variety of negative outcomes because of family income, educational attainment, cultural or linguistic isolation, and access to community resources. In Head Start programs, for example, children are served by professionals from education, health care, social services, and other fields in the same facility. In addition, caregivers are supported through this program with services. As a result, both Early Start and Head Start programs play an important role in providing at-risk youth with exposure to positive developmental experiences to enable these learners to make significant gains (Love et al., 2005; Reynolds, 2000).

Developmental science has contributed greatly to our understanding of risk and resilience, as well. Certain factors correlate with unfavorable developmental outcomes. Examples of developmental risks include poverty, teen parents, substance abuse, and poor-quality schooling. Individually, or in combination, these factors tend to occur in groups of children with later outcomes including teen pregnancy, substance abuse, unemployment or underemployment, and others. However, not every child exposed to risk factors has an unfavorable developmental outcome. Despite challenges, some children thrive while their peers, siblings, and parents experience hardship. Certain factors seem to offer protection against environmental harm for some children. This phenomenon is called resilience. Factors contributing to resilience include a positive role model, a mentor, academic success, and acceptance by healthy peers (Condly, 2006).

After-school programs also play an important role in the prevention of a number of negative developmental trends. Thus, they may contribute to resilience. One area of significant impact for after-school programs may be the reduction of criminal behavior. Studies report an increase in violence, crime rates, substance use, and sexual activity for youth during the period immediately after the dismissal from school (Riggs & Greenberg, 2004). Quality after-school programs provide a venue for engagement in appropriate activities under adult supervision and corresponding decreases in youth crime rates (Gottfredson et al., 2004). In addition to the benefit of providing a safe, supervised, and structured environment, children have the opportunity to enhance academic and social skills.

After-school programs may contribute to the physical health of youth, as well. For example, the rise in childhood obesity and related illnesses correlates with the decrease in physical education classes in schools and reduced extracurricular offerings. After-school programs can make a positive impact on increasing the health behaviors of young children (Mahoney, Lord, & Carryl, 2005).

In a comprehensive review of what is known about prevention programs across settings and topic areas, Nation et al. (2003) found that a skill development focus and the importance of proper timing were two of the most crucial indices of effectiveness. Thus, programs that are matched to the developmental progress and challenges of learners are most effective. Furthermore, specific learning objectives should be selected and effective instructional design must be applied to reap these benefits.

### ***Lessons Learned from Cognitive Science***

Cognitive science draws from a number of disciplines to address questions of mind, knowledge, language, memory, and other processes (Gardner, 1985). Cognitive science is held together by an interest in structures that underlie learning and the processes that they are governed by. Many areas of research emerge from this tradition. The contributions of Jean Piaget, Lev Vygotsky, and Howard Gardner are given attention because their work contains important implications for educational design.

#### **Piaget**

Jean Piaget is the author of one of the most prominent theories of child development (Piaget, 1965, 1971). It articulates the position of constructivism, which posits that the learner's active creation of mental representations of an event, or a schema, guide subsequent interactions. In constructivism, the learner engages in the world through experimentation and discovery, both naturally and in programmed settings.

Learning activities that are most valued by Piaget are those where children are allowed to experiment, analyze, and draw their own conclusions. Teachers arrange and facilitate experiences to help students discover information through questions, probes, and other strategies (also called the clinical method). Because learners are expected to actively construct new knowledge from these experiences, it is important that learners are properly prepared for this level of independence in their learning. This means that essential prerequisite skills must be present so that the learner can take advantage of discovery exercises. These prerequisites include direction following, sustained attention, peer cooperation, use of tools, communication skills, or the ability to read.

Research by Piaget and others had elaborated typical developmental milestones for youth of various ages. He proposed four developmental stages and associated skills that generally are observed at each stage.

The first stage of development spans the first 2 years of life. It is called the sensorimotor stage to emphasize the primary task and mode of learning during

this period: physical interactions with the environment. The use of one's senses to come to know objects, events, and individuals is important.

The preoperational stage is the second developmental task in Piaget's theory. It ranges from approximately years 2 to 6. Advances in thinking that take the child from literal and immediate sensory experiences to abstract representations of events characterize this stage. Children become able to use symbols and thus begin to understand words and numbers.

Concrete operations develop and the child enters the third stage. Here the child becomes able to manipulate symbols and use logic. Generally, this occurs between the ages of 6 and 11. Using words to tell a story or numbers to solve a problem are examples of working with the abstract concepts that are seen during this period.

The final stage of development is described as formal operations. Learners in this stage demonstrate higher-order abstract thought. As such, a broad range of possibilities can be conceptualized, evaluated, and compared by those who have developed these sophisticated ways of thinking.

Although these stages contain sufficient breadth to describe the development of most typical learners in stimulating circumstances, it is not the case that all learners achieve the level of skill described by each of the stages. This is particularly true regarding the final and most complex stage of development: formal operations. It is the position of Piaget that the advancement of a learner through these stages was a matter of the unfolding of particular levels of skill. The timing of a learner's advancement and how far a given learner was able to advance in the stages was not something that could be readily influenced by teaching.

Piaget's stages focus on cognitive development, which is facilitated by a few important processes. First, organization is used to fit new knowledge into existing repertoires. A second process is adaptation, which describes the modification of existing repertoires in response to new knowledge. Third, assimilation is determining if new information is like something already known or if it is so distinct from previous experiences that it becomes an example of a new category. This later process is called accommodation.

Piaget's theory of child development emphasized the importance of the learner as an active participant in their unfolding development. Piaget stressed the importance of the teacher as a guide. His lasting contributions are to encourage educators to present learners with challenging and meaningful learning opportunities in which they will have the opportunity to learn the way that the world works.

## **Vygotsky**

Lev Vygotsky's theory of social and cultural development has sparked intense interest. It is grounded in the premise that development is a culturally situated event, thus interactions with others are of primary importance in the

development of knowledge (Vygotsky, 1986). Language is the vehicle by which knowledge is transmitted from more skilled to less skilled members of a cultural community.

Vygotsky stressed the role of culture as a developmental catalyst. Children could learn more under the guide of a more skilled model or a mentor than they could learn on their own. In fact, his theory of development incorporates a number of processes that emphasize the importance of collaborative learning. The skilled mentor that arranged an apprenticeship in learning for the less learned partner greatly widened their range of abilities. The difference between what skills a learner can demonstrate independently and what can be done with assistance is called the zone of proximal development (ZPD). The more a child knows and is able to do, the more doors open to him or her for even more experiences, and development continues to accelerate.

A mentor can expand a learner's ZPD through a process called scaffolding. Scaffolding is a teaching method whereby learning experiences are arranged that build upon already mastered skills, engage the support of a skilled mentor, and expand the ZPD in a stepwise fashion. Once learners can do the new skill with assistance, they are exposed to it with diminishing levels of support until they can engage in it independently. This skill then becomes part of their repertoire and becomes increasingly covert or private in its presentation. An internal dialogue, referred to as private speech, comes to govern well-known skills. Simultaneously, still further advances in that area of knowledge are facilitated by again working with the mentor. The process is continually evolving and contributes to advances in the learner's thought and language and their ability to mentor others.

Vygotsky presented a theory of development that accounts for development through social interactions. His theory is readily brought into practice and as such has had an important role in shaping modern instructional environments.

## **Gardner**

Howard Gardner shares an interest in the development of cognitive skills with that of other cognitive scientists. His theory of intelligence distinguishes a variety of types of expert behavior (Gardner, 1993a, 1999). This theory of multiple intelligences outlines eight areas of skill that describe a given learner's abilities. The developmental evolution of particular inclinations evident in individuals is the focus of his work. Intelligence represents advanced skill in socially relevant domains (Gardner, 2003). It is a dynamic process, and by understanding and identifying what constitutes intelligence, we can support its evolution in young learners (Gardner, Csikszentmihalyi, & Damon, 2001).

One type of intelligence is linguistic. An individual who shows remarkable skill in writing and oration may have high linguistic intelligence. A second type of intelligence is logical-mathematical. The use of logical analyses and numerical computation by mathematicians and scientists demonstrates this type of

intelligence. Musical intelligence is a third category identified by Gardner. The composition and/or performance of works of music are evidence of this domain. A fourth area involves exceptional skill in the bodily-kinesthetic domains, such as that seen by those that work with their bodies like athletes and craftsmen. Spatial intelligence comprises a fifth domain. Architects, navigators, and pilots, for example, excel here. Sixth, a naturalist intelligence is seen in biologists, ecologists, and conservationists. Interpersonal intelligence describes working effectively with others like psychologists, human-resource professionals, and advocates do. Lastly, intrapersonal intelligence is demonstrated by depth of self-understanding and using this knowledge to guide one's life choices. Existential intelligence has also been included to describe advances in the understanding of life itself.

Gardner derived these areas from extensive research and factor analysis. These domains appears to reoccur across populations. Whether his definition of intelligent behavior is accepted, or that of another, Gardner's framework provides an excellent guide for educators as they develop an array of curricular experiences to promote and maximize development in socially significant domains (Gardner, 1991, 1993b, 2004; Kornhaber, Krechevsky, & Gardner, 1990).

Lessons learned from cognitive science include accounts of how development unfolds; models for how learners receive, interpret, store, and retrieve information; representations of mental processes; accounts of how learners may differ in motivation and ability; and techniques that promote theoretical learning events. Cognitive scientists have advanced our understanding of what we think and have proposed useful systems of explaining how thinking evolves. These advances can sensitize teachers to student's needs.

### ***Lessons Learned from Natural Science***

Natural science uses empirical methods to study measurable events in everyday settings (Bijou, 1993). Behavior Analysis is the application of the natural science of behavior to the solution of problems of social significance. The subject matter of behavior analysis is behavior, which includes everything one says or does. Behaviors are measurable events. This means that any given behavior must be well defined, able to be verified by others, and the appropriate measure must be selected to capture the picture of that behavior. Some behaviors are readily observed and measured by others. These are called overt or public events. The number of words read aloud per minute, time on task, and percent of time spent in peer activities are examples of overt behaviors. Behaviors that are most easily observed by the learner himself or herself are called covert or private events. Examples of covert behaviors include planning, reasoning, problem solving, remembering, dreaming, and thinking. The number of times a student asks for assistance on a task is easily observed by another individual, but the feelings of

calm that the relaxing beach oasis of your daydreams bring about are most easily observed through other means. It is important to note that private events, and even some public events, require different kinds of measures, but they are still observable because they are natural phenomenon.

The natural science approach to teaching and learning aims to provide efficient solutions to developmental challenges to increase the learner's success (Greer, 2002). This is done by applying the best practices in teaching and learning. Natural science as applied to the development of children emphasizes the principles of learning that underlie instances of development for the individual. It also examines the varied and complex influences on development that are exerted by such factors as family, education, culture, and society.

A natural science approach to development is guided by direct observation of the learner. Careful analysis of the learner's current skills and opportunities for growth focuses on five domains: the learner's motivation, the characteristics of the learning environment, the triggers for behavior, the performance of the skill, and the outcomes of behavior. These variables are combined with learner characteristics, their past history of successes, and areas for continued growth. This information creates an inclusive picture of how best to teach the learner to maximize their success. The actual teaching strategy that is implemented will be a function of this analysis as no single strategy or group of practices is effective for all learners.

Analysis of the first variable, the learner's motivation, includes previous experiences and immediate events. Motivation changes the likelihood that the learner will engage in different subject matter, instructional methods, and social settings. A shy child with few peer alliances may fail to complete a science experiment, for example, not because of lack of interest in the activity or knowledge in the prerequisite domains, but because the teaching method required peer cooperation and they were unlikely to engage in collaborative learning projects.

The setting where learning occurs contains a variety of events that influence learning, as well. For some learners, a room full of interesting stimuli increases their excitement about the task, and for others high levels of stimulation over-extend their ability to attend to the task. As such, the context that best suits the learning goal should be identified and arranged.

In a given setting, a particular event will trigger the learner to answer a question, complete an analysis, perform a skill, or other type of engagement in the curriculum. How best to provide instructional triggers so that the learner successfully participates in the learning experience is identified by the natural science approach.

Finally, feedback on the learner's performance that best contributes to their ongoing development is provided. All members of the teaching environment are engaged in providing positive outcomes for learning: the teacher(s), peers, and the student themselves. Learning is as individual as learners are unique. Thus, it is the charge of educators to provide information to learners about their

strengths and remaining learning opportunities in ways that best promote growth. This may mean using mentors, peers, everyday experience, or self-direction to enhance learning. Learners on the edge of a leap in understanding are described as “on the cusp.” Behavioral cusps open doors to new triggers, responses, and contexts for learning, thus they should be identified and expanded upon (Rosales-Ruiz & Baer, 1997).

Fredrick, Deitz, Bryceland, and Hummel (2000) identified three characteristics of Behavior Analysis that make it well suited to the design of effective, developmentally appropriate educational programs. First, it is focused on the unique experience of individuals in their environments. Next, it seeks to address challenges that learners face in everyday settings by examining those settings and developing solutions. Finally, it is science-based and uses the scientific method to address issues of development and learning for the purpose of identifying patterns, relationships, and causal variables that can support learning. Focusing on functional relationships between the learner and their environment allows educators to make significant changes in appropriate domains.

Program design grounded in evidence-based practice is the goal of natural science and its application in the field of Behavior Analysis. Behavior Analysis presents a rubric for examining learning events that is readily applied to all areas of development. Lessons learned from the natural science of behavior include descriptions of events that trigger learning; descriptions of events that maintain skills; descriptions of changes in motivation; prediction of the conditions under which different behaviors will occur; influence for positive behavioral choices; and teaching methods that establish, maintain, extend, and generalize basic through higher order skills. After-school programs guided by a natural science approach have lasting and deep impact of the learners they touch.

## Conclusion

Learning and the development of children are not passive events. Rather, a complex dynamic between learners and their environments shape their developmental outcomes. Important individuals, resources, discoveries, and collaborations propel the learner into new and more complex repertoires. Building a broad array of foundation skills for later learning is crucial. Growth results as physical, social, educational, and personal gains are made. It is the role of teachers to arrange conditions to maximize positive developmental trends and to provide protective barriers for potential threats to healthy development.

Teachers who know the strengths of and opportunities for growth of each for their students are more effective at designing meaningful and lasting instruction. Responsible programming is designed around the needs of learners using empirically supported best practices. It is implemented in a warm and caring

Table 2.1 Recommended practices across different areas of science

Cognitive science				
Developmental science	Piaget	Vygotsky	Gardner	Natural science
	Cooperation	Social interaction	Engage different modes	Build on current repertoire
	Exploration	Apprenticeship	Expose learners to different methods	Provide well-designed experiences
	Interaction	Cultural values	Encourage creativity	Provide the learner with the tools for success
	Experimentation	Collaboration		Use models to promote imitation
	Challenge	Guided participation		Encourage and motivate
	Child-driven	Expert partners		Make learning fun
	Teacher-arranged	Individualized assistance		Probe learning at higher levels
	Teacher-guided			Limit the detrimental effects of errors
	Facilitated learning			Provide immediate feedback
CAUTIONS	Self-discovery			Provide positive supports
				Facilitate true mastery
				Teach skills that are supported by environment, useful in many settings, and will help the learner to acquire additional skills
Must have well-designed learning assessments	Must separate individual performance from group	Do not pigeonhole in best area, expose to all areas	Remain dynamic, flexible, and driven by learner's performance	

**Table 2.2** General focus on learning in different scientific approaches

	Developmental science	Cognitive science			Natural science
		Piaget	Vygotsky	Gardner	
Nature				X	
Nurture	X	X	X		X
Operant conditioning	X	X	X	X	X
Respondent conditioning					X
Levels of learning		X		X	X
Fluency	X		X	X	X
Intentional learning	X			X	X
Incidental learning	X	X	X		X
Trial-and-error	X	X		X	X
Errorless	X		X	X	X

environment that values flexibility and consistently grows with the child. Well-designed programs are centered on specific instructional objectives. Progress toward these objectives is constantly measured, evaluated, and modified as indicated. Best practices are shared, because what works in education is not a secret to be protected, but rather the entitlement of all learners.

After-school programs have taken on the challenges of education that have been unmet by other supports. The continued support of after-school programming is contingent on the demonstration of positive outcomes (Xu, 2002). Thus, it is in the best interest of the learner, teacher, administrator, community, and funding agent that high standards of ethics, accountability, and integrity be maintained.

Guided by typical developmental trajectories and lessons learned from the scientific study of children, after-school programs show more promise than ever before. Outcome data reflect these trends. Chapters in this volume provide excellent accounts of what works in after-school programming for young children.

In closing, specific practices for use in effective and efficient after-school programming found in Tables 2.1 and 2.2.

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