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Shaping the Learning Environment: Connecting Developmentally Appropriate Practices to Brain Research

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Connections are shown between recent findings in brain research and principles of Developmentally Appropriate Practices to explore the implications for early childhood learning environments and teaching practices. New research on how the growing mind learns appears to bear out the value of NAEYC's constructivist approach to early childhood education where environments are designed to gain the learner's attention, foster meaningful connections with prior understanding, and maximize both short- and long-term memory through patterns and active problem solving. Each unique learner needs to feel challenged, but not fearful, so that stimulating experiences result in an exchange of ideas and promote deeper understanding.

KEY WORDS: early childhood education; brain research; developmentally appropriate practices (DAP); learning environments.

INTRODUCTION

The past several years have seen an explosion of published articles, books, and documentaries as well as a proliferation of conferences and workshop seminars focused on connecting recent neuroscientific research findings relating the child's developing brain to educational strategies. President of the James S. McDonnell Foundation, Bruer (1998), questions the validity of this marriage, stating clearly that "brain science has little to offer education practice or policy" (p. 14). He is supported by others who warn the educational community that knowledge gleaned from today's brain science may well be out-dated in several years due to its rudimentary nature. Indeed, many educators are quick to exert pressure on the educational pendulum in order to substantiate their philosophical position. However, although brain science is relatively new, Wolfe (1998), an educational consultant and expert on brain research, postulates that the bridge between neuroscience research and education is not the job of neuroscientists, but instead, that of educators.

Studies about how the human brain learns need to be interpreted in light of the classroom environment, because children spend a great deal of their time in these settings at a critical period in their development, and expectations for our professional success carry high stakes. The good news is that new research appears to be affirming what many early childhood educators have always known about effective learning environments. The bad news is that we have yet to fully explore the implications of this rapidly expanding area of knowledge in terms of generating widely recognized practices in the field of early childhood education. This paper is a beginning attempt to draw some parallels between brain research and the early childhood classroom, and so it should be acknowledged at the outset that the connections we propose here are tentative.

The National Association for the Education of Young Children's position statement on developmentally appropriate practices (DAP) for children birth through age 8 (Bredekamp & Copple, 1997) originally stated two main objectives, namely, (a) to provide "guidance to program personnel seeking accreditation by NAEYC's National Academy of Early Childhood

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Programs; and (b) to counter persistent beliefs in the prevailing traditional approach to early childhood education. The educational emphasis was on a didactic, teacher-centered approach to learning that encompassed primarily whole group instructional techniques (Bredekamp & Copple, 1997, p. v). Subsequently, DAP was revised to describe a philosophical orientation that now implies a constructivist approach to teaching young children. It is built on the premise that children are social learners who actively construct meaning and knowledge as they interact with their environment.

Research on what constitutes appropriate early learning experiences has focused during the past decade on both the social-emotional (Burts, Hart, Charlesworth, & Kirk, 1990; Hyson, Hirsh-Pasek, & Rescorla, 1990) and the cognitive (Dunn, Beach, & Kontos, 1994; Sherman & Mueller, 1996) development of young children. Studies indicate that children actively engaged in learner-centered environments score higher on measures of creativity (Hyson *et al*., 1990), have better receptive verbal skills (Dunn *et al*., 1994), and are more confident in their cognitive abilities (Mantzicopoulos; Neuharth-Pritchett, & Morelock, 1994; Stopek, 1993). Additionally, Frede and Barnett (1992) reported that children who attended developmentally appropriate programs in preschool performed better in first grade on standardized assessments of achievement. A study by Burts *et al*. (1993) indicated that children from low socioeconomic home environments who were enrolled in DAP kindergarten classrooms showed higher reading scores in first grade than their counterparts who attended more traditional classrooms.

Unfortunately, even with these studies, there exists a wide discrepancy between what research recommends and how children are currently being taught. Dunn and Kontos (1997) postulated that DAP programs are not the norm in early childhood programs as teachers have difficulty knowing how to implement such practices. They also reported that many parents are unaware of the significant benefits of a DAP program and therefore choose a more traditional learning environment for their children.

During the past decade a parallel body of literature has emerged, one that has potentially important implications for teachers and young children alike. Research in the fields of neuroscience (Diamond & Hopson, 1998; Fitzpatrick, 1995; Sylwester, 1997), cognitive psychology (Gardner, 1993; Goldman, 1995; LaDoux, 1996), and education (Caine & Caine 1991, 1997; Jensen, 1998; Kovalik, 1994; Wolfe, 1998), has provided some new information for teachers to better understand the learning process with implications for how to create more effective classroom environments. Combining knowledge across these disciplines could benefit teachers seeking ideas about best practices in designing environments that are consistent with what we now know about how the human brain learns. Specifically, brain research will help provide educators with strategies that can stimulate specific areas of the brain (thalamus, amygdala, hippocampus, and the frontal cortex) in order to gain the learner's attention, foster meaningful connections with prior understanding, and maximize both short- and long-term memory.

Brain research also supports the importance of developing and implementing a curriculum that is appropriate for the learner's particular developmental age. Early childhood teachers have been acutely aware for some time now that certain periods in a young child's life are more receptive for some kinds of learning. It is exciting to observe how the literature also indicates that particular "windows of opportunities" for learning do exist when the brain's plasticity, or adaptability, allows for greater amounts of information to be processed and absorbed (Wolfe, 1998).

Many teachers who embrace the early childhood philosophy are already practicing brain research-based strategies. Rushton (in press) describes a typical early childhood setting, for example, encouraging verbal interaction, integrating curriculum content areas, and providing meaningful problem-solving opportunities. Brain research, in and of itself, does not introduce new strategies for teachers; however, it does provide very concrete and important reasons why specific approaches to teaching and certain classroom strategies are more effective than others. As we will show, brain research seems to affirm many DAP principles and the underlying early childhood educational philosophy. With each DAP principle and brain research corollary, examples are provided on how to create, organize, and/or implement a learner-centered classroom that is compatible with both bodies of research. Not all principles are addressed since clear connections are not always evident. Table I outlines the parallels between the DAP standard and what we termed Brain Research principle. Additionally, the chart provides a few classroom strategies connect the two similar bodies of research.

DAP Principle 1

Domains of children's development—physical, social, emotional, and cognitive—are closely related. Development in one domain influences and is influenced by development in other domains.

Educators have known for some time that develop-

Table I. Different Strategies and Principles

DAP position[a]	BR principle[b]	Classroom environment[c]
1. Domains of children's development—physical, social, emotional, and cognitive—are closely related. Development in one domain influences and is influenced by development in other domains.	Each region of the brain consists of a highly sophisticated neurological network of cells, dendrites, and nerves that interconnect one portion of the brain to another. The brain's emotional center is tied to the ability to learn. Emotions, learning, and memory are closely linked as different parts of the brain are activated in the learning process.	Good curriculum naturally engages many of the five senses and activates more than one of Gardner's eight intelligences at the same time. Learning is a social activity, so children need opportunities to engage in dialogue. Multiage grouping is a strategy that can support and challenge a range of learning styles and capabilities. Good learning environments build trust, empower learners, and encourage students to explore their feelings and ideas.
2. Development occurs in a relatively orderly sequence, with later abilities, skills, and knowledge building on those already acquired.	The brain changes physiologically as a result of experience. New dendrites are formed everyday, "hooking" new information to prior experiences. An enriched environment increases cell weight and branching of dendrites.	Hands-on activities stimulate the various regions of the brain, and active participation helps young children to form stronger associations with existing understanding. Different stages of play (solitary, parallel, associative, collaborative), for example, can be identified and appropriate activities designed to build increasingly complex ideas through play.
3. Development proceeds at varying rates from child to child as well as unevenly within different areas of a child's functioning.	Each brain is unique. Lock-step, assembly-line learning violates a critical discovery about the human brain: each brain is not only unique, but also is growing on its own timetable.	Environments should allow choices to accommodate a range of developmental styles and capabilities. Large blocks of time, and systems for planning and tracking work, can be organized for children to share responsibility for their activity choices. Teachers need to adjust expectations and performance standards to age-specific characteristics and unique capabilities of learners.
4. Early experiences have both cumulative and delayed effects on individual children's development. Optimal periods exist for certain types of development and learning.	Brain research indicates that certain "windows of opportunity" for learning do exist. The brain's "plasticity" allows for greater amounts of information to be processed and absorbed at certain critical periods (Wolfe, 1998). The critical period for learning a spoken language is lost by about age 10 (Sorgen, 1999).	Children need opportunities to use sensory inputs, language, and motor skills. Young children also require frequent opportunities to interact verbally with peers. Repeated opportunities to interact with materials, peers, and ideas are critical for long-term memory. Second language programs will be most successful before 5th grade and should start as early as possible.
5. Development proceeds in predictable directions toward greater complexity, organization, and internalization.	The brain is designed to perceive and generate patterns. The brain is designed to process many inputs at once and prefers multi-processing. Hence, a slower linear pace reduces understanding. (Caine & Caine, 1997)	Finding patterns can be built into math, language arts, science, and other subject area curriculum. Learning environments need to be organized for both low and high order thinking skills. The use of metaphor, and repeated opportunities to compare and contrast through multiple modalities, allow children to differentiate increasingly complex schemas.
7. Children are active learners, drawing on direct physical and social experience as well as culturally transmitted knowledge to construct their own understanding of the world around them.	When a child is engaged in a learning experience, a number of areas of the brain are simultaneously activated. Children raised in nonacademically oriented environments have little experience in using decontextualized language. They are more inclined to reason with visual, hands-on strategies (Healy, 1990).	Learning should be presented in a real life context so that new information builds upon prior understanding, and then generalizes to broader concepts. Field trips, guest speakers, interactive technology, and multicultural units of study will help children better understand themselves and succeed in today's world. In environments where children can interact with diverse populations (various cultures and generations—including grandparents), and use language as well as visual-spatial strategies, their learning will be enhanced.

Table I. (*Continued*)

DAP position[a]	BR principle[b]	Classroom environment[c]
8. Development and learning result from interaction of biological maturation and the environment, which includes both the physical and social worlds that children live in.	Each of the senses can be independently or collectively affected by environmental factors that in turn will affect the brain's ability to learn. Enriched environments increase dendritic branching and synaptic responses (Diamond, 1998). The simple act of reading a book may be one of the most challenging tasks the brain must perform. Speech comes naturally, but reading does not (Sorgen, 1999).	Environments should be carefully monitored for appropriate lighting, aromas, ionization (fresh air), and noise. Water and appropriate foods should be made available to children, remembering that each person's internal clock differs. Environments should offer a wealth of materials and activity choices to explore. Children need to understand the relevance of learning to read. Learning to read should be connected to the child's speaking and writing. Reading aloud and reading for meaning are two different processes, and children need opportunities to do both.
11. Children demonstrate different modes of knowing and learning and different ways of representing what they know.	"The mental mechanisms that process music (and rhyme and rhythm) are deeply entwined with the brain's other basic functions, including emotion, perception, memory, and even language" (Sorgen, 1999, p. 56). The most powerful influences on a learner's behavior are concrete, vivid images. The brain has a primitive response to pictures, symbols, and strong, simple images (Jensen, 1995).	A classroom should provide opportunities for individual children to learn via modalities other than just verbal/linguistic or logico-mathematical tasks. Rhyme and rhythm are memory aids. Children should be able to express knowledge in a variety of forms. Dramatization, music, and the visual arts should be made readily available as modes of both learning and expression. Symbolic representation can easily be built into the arts.
12. Children develop and learn best in the context of a community where they are safe and valued, their physical needs are met, and they feel psychologically secure.	Brain research has clearly demonstrated that high levels of stress, or a perceived threat, will inhibit learning. (Caine & Caine, 1997) The brain is primarily designed to survive. No intelligence or ability will unfold until or unless given the appropriate model environment" (Jensen, 1996).	The classroom environment should connect learning experiences to positive emotions. Students need to make decisions and choices about learning that is meaningful to them. The classroom culture should support risk-taking, and view failures as a natural part of the learning process.

[a]NAEYC's positions on Developmentally Appropriate Practices (DAP)
[b]What brain research (BR) suggests about how the brain learns.
[c]Strategies that incorporate both BR and DAP.

ment in one area is either influenced by, or is influencing another area of development. For instance, Graves (1983), Adams (1990), Weaver (1990), and others have articulated how reading and writing are connected; as a child begins to explore letters, sounds, and writing the desire and capacity to interpret, recognize, and understand these symbols increases simultaneously. And of course, this is conditional on the child's ability to see and hear—two very separate, yet interconnecting physiological functions. With even younger children, becoming mobile increases their ability to explore and understand their immediate environment. This increased activity also helps to stimulate cognitive development as they begin to interact and make sense of their surroundings (Kostelnik, Soderman, & Whiren, 1993; Sroufe, Cooper, & DeHart, 1992).

Each region of the brain consists of a highly sophisticated neurological network of cells, dendrites, and nerves that interconnect one portion of the brain with another. New stimuli entering the body via the five senses are directed immediately to the thalamus. The thalamus acts as a sorting station and reroutes the sensory input to various parts of the brain that deal specifically with each sense. These portions of the brain, called lobes, consist of millions of cells related to the specific sense that is being stimulated. For instance, the occipital lobe relates to the receiving and processing of visual information, and is located near the rear of the brain. The temporal lobe relates to language development, writing, hearing, sensory associations, and, to some extent, memory. It is located in the mid-left portion of the brain. The parietal lobe relates to higher sensory, language, and short-term memory. Finally, the frontal lobe helps us in our ability to judge, be creative, make decisions and plan. Learning does not take place as separate and isolated events in the brain—all these parts work together.

When a child is engaged in a learning experience a number of areas of the brain are simultaneously activated. Each lobe interacts cohesively, not as separate or isolated organs, but as interdependent collective units (Sylwester, 1997), and all of them are needed in order to read and write. For instance, reading a book requires that the child picks up a book, (activating the motor cortex: movement); she looks at the words, (activating the occipital lobe: vision); she attempts to decipher words (activating the temporal lobe: language); and finally, she begins to think about what the words mean (activating the frontal lobe: reasoning) (Sorgen, 1999).

We know that learning and memory are strongly connected to emotions, and thus, the learning environment needs to be both stimulating and safe. Classroom experiences can be designed to allow children to investigate, reflect, and express ideas in a variety of ways that are increasingly complex and interconnected. Gardner (1993) proposed that each individual draws on multiple intelligences and generally relies on some more than others. Thus, learners need ample opportunities to use and expand their preferred intelligences, as well as adapt to and develop the other intelligences, which are all interdependent within the one brain. Then, they need opportunities to express what they know and understand in a variety of formats.

Early childhood teachers need to recognize developmental characteristics among children in a group, as well as each learner's unique capabilities. Multiage grouping is one strategy that helps to facilitate learning for a range of abilities (Kasten & Clarke, 1993). Because all the children in the class are not the same age, children can recognize more readily how individual approaches to learning tasks are both distinctive and viable. Here, what a child knows and how he knows it is not so much a factor of age as of prior experience and learned meanings. In this, or any environment, teachers of all ages will want to foster a learning context that builds trust, promotes self-direction, and encourages students to freely exchange their feelings and ideas so that the social/emotional realm is connected positively to cognitive and physical experiences.

DAP Principle 2

Development occurs in a relatively orderly sequence, with later abilities, skills and knowledge building on those already acquired.

DAP Principle 3

Development proceeds at varying rates from child to child as well as unevenly within different areas of a child's functioning.

We learn to sit before we crawl, and crawl before we walk. In this way, human development is ordered and sequential. Developmental psychologists have described how stages of physical, cognitive, and social development are stable and predictable over time especially in children during the first 9 years of life. Notable pioneers such as Piaget (1952) and Erikson (1963), for example, proposed different stages of play and socialization that, providing normal development, are observable, predictable, and measurable. In these hierarchies, no stage can be skipped over as the developmental process unfolds.

Wolfe and Brandt (1998) stated that the brain changes physiologically as a result of experience. As the child experiences an event for the first time, either new dendrites are formed, or the experience is associated with a similar past event hooking new information to old understanding. Much of our behavior and development is "hardwired" through a long history of human evolution (i.e., breathing, circulation, and reflexes). However, individual brains are also "softwired" in order to adapt and create new neurological networks in response to the unique environmental stimuli encountered in our individual lives. It is in the interplay between environment and genetics, hardwired automatic behaviors and softwired developing neuronetworks, that we need to be sensitive to differences among children.

Each child's uniqueness is expressed in a number of ways: personality, temperament, learning style, maturation, speed of mastering a skill, level of enjoyment of a particular subject, attention, and memory. These attributes help to identify how a particular child will learn and what style of teaching is best suited for him or her. Further, each brain's growth is largely dictated by genetic timing, and therefore is as individualized as DNA (Sylwester, 1995). In truth, there are no homogeneous groups of children; as no two children are the same, no two brains are the same. Wolfe (1998) put it succinctly when she stated: "The environment affects how genes work, and genes determine how the environment is interpreted" (p. 10).

IMPLICATIONS FOR PRACTICE

Early childhood teachers have learned that children progress through various stages of development, knowing that each child's rate of development (and each brain) is unique and different. Providing hands-on activities that both cater to the differences among children and stimulate various regions of the brain reinforces stronger associations of meaning and makes learning inherently more interesting. Teachers who are trained to observe each child's development can establish a responsive environment for different documented stages of play (solitary, parallel, associative), and carefully design appropriate activities for the child's level. Teachers of older students can pay attention to higher order thinking skills in a similar manner, challenging students with engaging problem-solving opportunities. Teaching complex skills too soon may impede learning, and conversely, not teaching children when they are ready may result in boredom and a lack of interest.

Activities that have different levels of complexity allow every child access both to the content ideas and to conversation with peers. Creating centers around the classroom with a range of problems to solve and materials to use can accommodate the differences among learners. A general overall theme may permeate the activities in each center so that the children see connections across subject areas. A center (Rushton, in press) approach can easily be adapted from preschool to third grade, using planning sheets and individualized contracts to help children discover for themselves what their particular strengths and challenges are.

Because each learner is so different, children should be able to choose activities that fit their level of development, experience, and interest. Thus, teachers will want to use a variety of teaching methods and materials to ensure that every child becomes interested in exploring ideas, so that their auditory, visual, tactile, or emotional preferences are accounted for. More important, teachers need to remember that each child's educational experiences inside the classroom plays a part in shaping a lifetime of learning habits. Different children feel challenged by different problems, and threatened by different social circumstances, and these matter in what and how they learn.

DAP Principle 4

Early experiences have both cumulative and delayed effects on individual children's development. Optimal periods exist for certain types of development and learning.

Principle 4 suggests that each learning experience lays groundwork for future learning, either positively or negatively. The child's ability to learn and interpret new information is directly related to the frequency of prior experience with related ideas. Brain research also indicates that certain windows of opportunities for learning do exist (Sorgen, 1999). In some instances, it is vital to development that a particular sense be stimulated. For instance, it has been demonstrated that some animals have had their vision obscured at key times in their development and were unable to ever see again. The blueprint, so to speak, relating to vision simply cannot be reestablished if not stimulated to grow in the first several years (Wolfe, 1998). The same can be said for developing oral language. In extreme cases in which a child has been abused, neglected, and cut off from society, speech pathologists have been unable to help those individuals speak normally.

Language and motor development both require children to actively engage with others. Conversation and physical activity are extremely important for the development of the brain. To facilitate optimal development, young children require opportunities to interact with each other regularly, to encounter new vocabulary, construct arguments, express emotions, and stretch their muscles. Thus, learning environments should encourage verbal interactions, moving around the room as children work on projects or pursue a line of inquiry, and plentiful occasions to use manipulative materials including gross motor equipment.

Second language acquisition is most successful prior to fifth or sixth grade when the necessary structures in the brain for language learning are still in place. Young children seem to be particularly adept at mimicry, especially when language is rhythmic and rhyming. Also, the brain looks for patterns and connections, and repetition is critical for long-term memory. Introducing young children to more than one language is extremely beneficial, even if they do not yet understand how language is structured grammatically or written down. This early learning creates a foundation for later, more formal, study of another language.

DAP Principle 5

Development proceeds in predictable directions toward greater complexity, organization, and internalization.

The brain is designed to perceive and generate patterns and is constantly seeking to place new information into existing neurological networks. If no prior network exists, then new dendrites will be formed. Each layer of learning builds upon former networks. It has been suggested that the myelin sheath that surrounds the axons (the long tentacles of a dendrite) thicken with repeated exposure to a thought, idea, or experience. The greater the complexity of an experience, the thicker the myelin becomes. The belief is that thicker myelin results in faster recall of an event and greater memory (Diamond & Hopson, 1998). If this is true, then repetition of activities helps to thicken the myelin and thus, reinforce students' understanding.

Since no two children learn at the same rate, it is crucial that children be given repeated opportunities and ample time to explore, play, and socialize while they work in various curriculum areas (paint, blocks, dramatic play, listening center, water table, science). A typical K–3 classroom covers content in reading, writing, and mathematics, and time permitting, social studies, science, and the arts. Curriculum is often presented as separate subjects in distinct units with little overlap. Information would be better presented in a context of real life experiences where new information can build upon prior knowledge, so that learners understand how it is meaningful to them. Field trips are an excellent strategy to connect new learning to real world applications. When studying pollution, for example, students might visit the landfill, clean water treatment center, the recycling plant, or local municipal garbage collection center rather than just viewing pictures and reading texts about the subject. The learner should be able to connect new information to well-established conceptual frameworks in an experiential manner, not as isolated bits of information that have no meaningful connection.

DAP Principle 7

Children are active learners, drawing on direct physical and social experience as well as culturally transmitted knowledge to construct their own understanding of the world around them.

DAP Principle 8

Development and learning result from interaction of biological maturation and the environment, which includes both the physical and social worlds that children live in.

The environment in which a child learns, both the explicit physical surroundings (people, manipulative materials, books) and the implicit cultural norms, (alphabet, numerical symbols, values) shapes that child's understanding of the meaning of his or her experiences. Bredekamp and Copple (1997) stated that "young children actively learn from observing and participating with other children and adults" and that they need to "form their own hypotheses and keep trying them out through social interaction, physical manipulation, and their own thought processes" (p. 13).

The human brain is constantly seeking information from a variety of stimuli. These data are interpreted through all the senses and are then organized by the brain. Since each of the senses can be independently or collectively affected by environmental factors, they will affect the brain's overall ability to learn. Therefore, it stands to reason that the learning environment should make children physically comfortable—they need good lighting, fresh air, and a reasonable level of noise. In addition, children cannot learn when they are hungry or tired because their minds will be focused on the body's signals to eat or sleep. They need to move around to oxygenate their blood and exercise their muscles.

The social environment in a classroom relies heavily on language, and the simple act of reading is one of the most challenging tasks the brain performs. But the brain perceives patterns, and so we can help children develop language skills by looking for letter patterns in words, word patterns in sentences such as rhyming or alliteration, patterns in story sequence, and the like. Most importantly, we need to help children see the relevance of learning language and becoming competent readers, so that their motivation to learn and attention to the challenge are both high. The learning environment can reflect children's interests by including them in conversations about which books will be read.

Children who have been raised in nonacademically oriented environments have less experience using decontextualized language than their peers. In other words, they are less apt to rely on words to describe events to others outside the context where they occurred, and oral language skill development will affect later reading ability (Snow, Tabors, & Nicholson, 1995). These children may communicate more readily through using visual images, physical activity, and symbolic representation.

The curriculum can include practice in storytelling as a way to develop oral language skills and to make connections with children's real world experiences at the same time. The more children are exposed to and talk about experiences that are new to them, the more connections they can make to what they already know. Children also need opportunities to express ideas and understanding in physically active ways, such as through visual and dramatic arts. Repeated practice helps children to recall information and master physical tasks. As new information builds on prior understanding, children are able to generalize their own experiences to broader concepts.

DAP Principle 11

Children demonstrate different modes of knowing and learning and different ways of representing what they know.

Gardner's (1993) work in multiple intelligences and assessment has pointed to the need for classrooms to provide more occasions for children to use music, bodily-kinesthetic, visual-spatial, and interpersonal domains to learn and express understanding. Brain research has indicated that the "mental mechanisms that process music (and rhyme and rhythm) are deeply entwined with the brain's other basic functions, including emotion, perception, memory, and even language" (Sorgen, 1999, p. 56). If music and movement can be used to build children's social/emotional experiences in the classroom, and to reinforce memory, language development, or even mathematical skills, we are likely to reach more kinds of learners than we would if we relied solely on narrowly defined subject areas.

Jensen (1998) has said that the most powerful influences on a learner's behavior are concrete, vivid images. The brain, he added, has a primitive response to pictures, symbols, and strong, simple images. It follows, then, that our systems of symbolic representation (the alphabet and numbers) are learned better if they can be connected to concrete, vivid images such as pictures and expressive motions. Children's memories are helped by physically representing what they know in addition to using language, so the arts should hold an important place in the curriculum. Children can draw, paint, construct, and dramatize what they know and understand.

DAP Principle 12

Children develop and learn best in the context of a community where they are safe and valued, *their physical needs are met*, *and they feel psychologically secure*.

Research on the brain and learning has clearly demonstrated that high levels of stress, or a perceived threat by the child, inhibits learning (Caine & Caine, 1997). It is the brain's principal job to ensure survival. The brain's emotional center is tied to its ability to learn. The amygdala checks all incoming sensory information first to see if it fits a known impression of danger. If a threat is perceived, the ability to learn is greatly impeded as the entire body automatically gears up to defend itself.

Teachers have a central responsibility to create a learning environment that feels relaxed enough to allow children's attention to focus on the curriculum, and challenging enough to excite interest. Evaluation is one component of the educational milieu, and thus, all assessment situations need to avoid generating a perceived threat. Clearly, using a variety of methods for collecting data enhances the likelihood of matching an individual learner's ways of knowing, and provides a more complete picture of what is known and understood.

Emotions, learning, and memory are closely linked as different parts of the brain are activated in the learning process. It is crucial, especially during the first several years of the child's life, to provide a rich and safe environment that lays groundwork for this neurological network to develop. Early childhood programs ought to invite children to make choices about what and how they learn so that they are more willing to take risks and view their experiences as both relevant and positive. Children need to explore, play, and discover, in a safe and healthy environment, using all of their senses in making connections from one part of the curriculum to another.

CONCLUSION

Technological advancements during the past decade have seen the development of some sophisticated equipment that has helped to better understand the functions of the human brain. This technology and subsequent understanding of the brain, albeit overwhelming for most educators, supports many of the philosophical tenets of constructivism, rooted in the philosophy of Dewey (1964). He believed that children learn best when interacting in a rich environment. He also believed that children constructed meaning from real life applications, and further, he knew that when various senses were used simultaneously, the probability of learning would be greater. Our modern educational terminology—such as integrated curriculum, whole language, hands-on learning, authentic assessment, and developmentally appropriate practices—not only echoes brain research, but also, we believe, contains many of the underpinning beliefs, thoughts, and tenets of Dewey.

Brain research helps to explain further why constructivist educators such as Dewey (1964), Piaget and Inhelder (1969), and Vygotsky (1967) still prevail. It is hoped that with new understanding about how the brain works, combined with the tenets of Developmentally Appropriate Practice, our ability to educate future generations will be greatly enhanced. The neuroscientist's job is to better understand the workings of the mind and brain; it is our job, as educators, to carefully sift through their findings and connect them to what we know empirically about how children learn best.

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