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Connecting Brian Cambourne's Conditions of Learning Theory to Brain/Mind Principles: Implications for Early Childhood Educators

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This article connects Brain Cambourne's Conditions of Learning to a constructivist philosophy of education as well as to established brain-based principles. Various classroom conversations between primary-aged children illustrate specific classroom activities that help link the brain principle to each of Cambourne's conditions.

KEY WORDS: brain-based research; constructivism; classroom environment.

INTRODUCTION

Learners of all ages attempt to make sense of the world around them and their experiences by synthesizing the present moment, skill, or concept being taught with their own prior knowledge, conditions of learning, and mental understandings. Young children in particular generate internal rules or schemas to better understand and connect what they are experiencing, or being taught, to what they have learned previously. Constructivists believe that the learner generates or constructs a personal understanding of the environment through a process of interaction, reflection, and action (Dewey, 1938; Hausfather, 2001). A main tenet of constructivism is the belief that the learner builds knowledge in active response to sensory experiences (Saunders, 1992; Wood, 1995). During this interactive stage, cognitive structures are stimulated in the formation of "knowledge construction," as students contemplate both their actions and the environment (Noddings, 1990; von Glasersfeld, 1995).

Piaget (1954), an early proponent of constructivism, proposed a developmental theory espousing universal forms, or structures of knowledge, that follow a developmental sequence of growth (preoperational, operational, concrete, and abstract operations). In reference to Piaget's work, Lincoln (2001) stated that the "individual constructs knowledge and makes meaning through interpretation of his own experiences and analyses of the environment" (p. 12). Piaget and Inhelder (1969) postulated that knowledge comes neither from the subject itself nor the object, but from the unity or interaction of the two. Further, Vygotsky (1978) purported a sociocultural version of constructivism, believing that understanding is generated by the learner's interaction with the social milieu. In both cases, constructivists propose that understanding is created when the learners are engaged in using their cognitive processes in relation to their bodies and within the context of the physical world of materials, symbolic tools, and nuances of their culture.

Brian Cambourne (1988, 1995), an Australian educator, developed a theory of learning as it applies to literacy learning. After 3 years of observing and monitoring the language development of young children, he synthesized his works in what he refers to as Conditions of Learning (1988). Cambourne's Conditions of Learning hold true to a constructivist perspective and suggest a concrete and viable means to enhance student development in literacy learning. He outlined a series of interactive processes teachers can use to facilitate students' un-

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derstanding of the learning process. Postulating eight interconnected and reciprocal conditions, Cambourne's theory provides a dynamic and evolving model for literacy learning. This model revolves around the following concepts: (a) immersion, (b) demonstration, (c) engagement, (d) expectations, (e) responsibility, (f) employment, (g) approximation, and (h) response. Each of these conditions supports both the student and the teacher in their discovery of learning and helps provide a context within which to learn. Cambourne suggests that the eight Conditions of Learning create an interactive and dynamic experience between the learner and the content. The purpose of the present article is to compare and link Cambourne's eight conditions of complex learning to that of the recent body of literature of brain research. Cambourne often uses literacy development as an example of how the student learns a complex series of skills; this article relates his theory of literacy/learning development to the various findings relating to brain research and learning in general.

Cognitive development and brain research-based teaching strategies complement both Cambourne's (1999) Conditions of Learning literacy and a constructivist philosophy. The past decade has seen a substantial increase in seminars, conferences, and published articles related to brain research and teaching strategies. Specific research in the areas of cognitive psychology (Gardner, 1993; Goldman, 1995), neuroscience (Diamond & Hopson, 1998; Sylwester, 1997), and education (Caine & Caine, 1997; Jensen, 2001; Rushton, 2001) has revealed new and exciting possibilities to aid to teachers' understand of the learning process and to become more effective in the process. Professional educators are beginning to link these findings to classroom management and learning environments as well as developmentally appropriate practices for young children (Rushton & Larkin, 2001).

Recent findings are supporting teachers to better design classroom environments that encourage the child's innate capacity to learn. Rushton and Larkin (2001) state that brain research will "help provide educators with strategies that can stimulate specific areas of the brain (i.e. the 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" (p. 26). In their article, these authors compared developmentally appropriate practices to several brain-researched principles that they extracted from the literature. Rushton (2001) describes a typical early childhood setting, one that is both developmentally appropriate and brain compatible. This setting helped create opportunities for the students to take responsibility for their learning, encouraged literature response activities, allowed for open dialogue to take place between the students and the teacher, fostered the integration of curriculum across all content areas, and provided opportunities for meaningful problem solving.

LINKING CAMBOURNE'S MODEL TO BRAIN RESEARCH

Reflecting on our years of teaching, we have discovered that no matter what the age (pre-K or graduate students) or the content (whether it is a second graders studying the rain forest or in-service teachers studying the writing process) the same constructivist, brain-research principles, and Conditions of Learning when applied, help foster a creative learning environment for students to develop their knowledge and grow as independent problem-solvers. Using Cambourne's framework, we believe that all students need to first of all be *immersed* into the culture, knowledge, and curriculum in order to make sense of their own learning styles, behaviors, and content. The second Cambourne condition is to provide exciting and stimulating *demonstrations* to assist the learner in experiencing the desired outcome. While being immersed in the learning environment and viewing demonstrations, the learner must be *engaged* in the learning process (i.e., experiencing, writing, creating their own guidelines, and formulating their own mission statements). As educators, it is our job to set *expectations* high enough so as to challenge the students yet without the risk of failure. In so doing, the students can master the content and take *responsibility* for their learning in a manner that is appropriate for their best learning styles. It is our job to provide ample experiences and opportunities for the learner to *employ* or *use* the learning both individually and in a social setting. Providing opportunities for the learner to *approximate* the desired outcome without fear of criticism or chastisement is an important component of the learning process. Finally, as facilitators and guides in this process, it is our primary role as teachers to provide feedback and a *response* to the entire learning experience, so the students can assess where they are in terms of desired outcomes.

With this in mind, we have attempted to connect some of the principles of brain research to Cambourne's Conditions of Learning and to the constructivist perspective. In the sections that follow, each of Cambourne's conditions is paired with a finding from the brain research. This is followed by specific examples on how to create, organize, and/or implement a child-centered learning environment. It is our belief that Cambourne's

Conditions of Learning and brain principles are applicable to learners of all ages. Table I outlines the parallels between the Cambourne's Conditions and what we have termed brain-research principles to a constructivist classroom orientation.

Condition of Learning: *Immersion*
Brain Principle One: *An enriched learning environment increases cell weight, branching of dendrites, and synaptic responses within the brain.*

Cambourne's (1988, 1995) first condition of learning relates to the importance of having students immersed into the literature, or as he states, "flooded by, steeped in, saturated by, and enveloped in" (p. 185). A literature-based and print-rich classroom allows for different forms of texts that are created by the children and reflects the real world. Whole-language advocate Desjean-Perrotta (1996) postulates that Cambourne's concept of Immersion fits a whole-language classroom as students are immersed in a rich variety of texts, different genres—including trade books, posted signs, poems, big-books, and songs—providing ample opportunity to see and experience the language.

The concept of immersion is not new, and yet, it is often the first part of the learning process that is found missing in the traditional paradigm of instruction. Students of all ages often find themselves sitting for long periods of time listening to the teacher, followed by working on textbook handouts, that is, reading a narrative on a given topic and answering short essay questions. For some learners this didactic method will work. However, this form of instruction may unnecessarily complicate the process of learning. A vastly different experience would be if the students were immersed in a theme, such as pollution, with numerous informational texts (Web sites, interviews, and trade books) and field-trips to the waste/clean-water treatment centers, a local landfill, and/or the city's recycling center. Then students could experience the learning processes via both their senses (seeing, smelling, touching, and listening) and intellectual stimulation (reading, analyzing, writing) and, thereby, become involved in the issues and solutions of dealing with limited planetary resources.

The conversation shown in Fig. 1, which occurred in a primary classroom, highlights many of this article's key concepts. These students are involved in a variety of projects taking place simultaneously in their classroom, several of which are related to the most recent unit of study—pollution. The morning is beginning and several students are deciding where to go and how to plan out their day.

After returning from several field trips, the students appear to be immersed in the curriculum, are taking responsibility for their learning, and are generally more excited. Learning environments and teaching philosophies such as the one depicted in the conversation of the students in Fig. 1 are growing throughout Canada, New Zealand, Australia, England, and more recently, in the United States. These interactive classrooms reflect a shift in teaching paradigms from teacher-directed traditional classroom to student-oriented, problem-solving learning environments that espouse a constructivist, brain research-based approach to learning.

Cambourne's concept of immersion is closely linked to the importance and necessity of the brain being stimulated with a wide variety of impulses. The different regions of the brain (or lobes) are connected through a highly complex system of synaptic neurological networks of dendrites. Research suggests (Sylwester, 1997) that with each new learning experience, the cells of the dendrites branch out to connect with other dendrites, and with repeated exposure to a learning task, the myelin sheath that surrounds the axon portion of the dendrites thickens; hence, the greater the difficulty or complexity of the learning taking place, the more the myelin sheath grows. The belief is that the thicker the myelin sheath the more encapsulated the learning is and the faster the memory response time is in recalling information. Diamond (1998) states that an enriched learning environment increases cell weight, branching of dendrites, and synaptic responses within the brain.

Brain theorists indicate that the brain is both "hardwired" with basic survival networks such as breathing, circulation, and some argue, instinct to recognize danger (Sylwester, 1997) and "softwired" in order to learn and be flexible to the environmental changes. For instance, over the course of human evolution, a region of the brain has developed to incorporate language as part of our ability to interact with one another. A healthy infant has the ability to learn any of the world's 3,000 languages. Through social interaction and cultural support, an infant's neurological network is formed and cultivated for the particular language to which child is exposed. If a child is exposed and immersed in more than one language, especially during the formative years (1 to 5) the developing cell weight and expansion of dendrites is increased. However, if one of the languages is not used as often, a process of "neural pruning," occurs in which the language may atrophy over time and the network of sounds disappears (Sylwester, 1997).

Implicit in this principle is that impoverished environments generate fewer synaptic connections, less cell weight growth, and fewer connections between den-

Table I. Linking Cambourne's Conditions of Learning to Brain Research

Cambourne's Conditions of Learning as It Applies to Literacy	What Brain Research (BR) Suggests About How the Brain Learns	Implications for a Constructivist Classroom
Conditions	BR Principle	Classroom Environment
Immersion		
Classroom teacher provides opportunities and makes available many different forms of text that are appropriate to the child's world.	The different regions of the brain are connected through a complex system of synaptic neurological networks of dendrites. An enriched environment increases cell weight, branching of dendrites, and synaptic responses (Diamond & Hopson, 1998).	Labels, signposts, books, magazines, shared/interactive writing on walls, both children's and teacher's writings displayed throughout the environment. Environment print literature of their world: K-mart bags, menus, cereal boxes, M&M wrappers, child-oriented language that applies to their lives and world.
Demonstration		Teacher demonstrations:
Children need to be able to explore with all their senses and have modeled for them language and reading. This condition infers that learners have modeled the action, skill, or knowledge that is to be learned.	The brain changes physiologically as a result of experience. New dendrites are formed daily, "hooking" new information to prior experiences.	Reading aloud, reading for expression, modeling the love of reading by using the child's world of written text, e.g., postcards, menus, comics, magazines, newspapers, letters from relatives. Writing—thinking aloud through the writing process, demonstrating how the mind is processing with modeled, shared, and interactive writing.
Engagement		
Children need to be active participants in their learning. Talking, discussing, sharing are critical ingredients for children in their language development. Opportunities need to be provided that allow for both independent and shared discussions and writing.	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 & Brandt, 1998).	Learning environments must provide a wide range of opportunities for children to talk, share, explore, and play. Centers provide choice to meet individual differences. Meaningful and relevant integrated thematic units can engage the students in learning that will create opportunities to discuss, write, and talk.
Expectation		
Teacher's belief and expectations in learner's abilities are critical to develop the child's interest and aspirations to succeed.	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. Positive emotions drive attention, which in turn drives both learning and memory (Wolfe & Brandt, 1998).	Teacher's presence and support is critical in creating a safe a trusting environment that establishes clear goals and expectations to permit all to succeed. Teachers should also use language that justifies the expectations that have been made explicit.
Responsibility		
Teachers need to model and immerse children in their learning by providing choices for individual differences. Responsibilities include decision-making on the part of the learner for choices and engagement.	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 period (Wolfe & Brandt, 1998).	Students need ownership of activities and themes that are relevant to their lives. Teacher creates opportunities for students to explore various types of text and literary activities that enhance their development. The use of planning boards and preselected activities that are negotiated helps students choose from a variety of activities and take responsibility for their learning.
Employment		
As children explore language, they need to be provided time and opportunity to do so both in a social and individual setting.	When a child is engaged in a learning experience, a number of areas of the brain are activated simultaneously.	Teacher offers adequate time for students to employ their unique gifts and abilities and to apply what has been demonstrated. Providing opportunities for paired and cooperative learning supports the need for social interaction.

Table I. (*Continued*)

Cambourne's Conditions of Learning as It Applies to Literacy	What Brain Research (BR) Suggests About How the Brain Learns	Implications for a Constructivist Classroom
Conditions	BR Principle	Classroom Environment
Approximation		
A child is not expected to wait until he has mastered the narrative language before talking, not is it possible for a child to learn to write without going through various stages. Educators should permit learners to take risks and make approximations in learning new skills, concepts, and knowledge.	The brain is designed to perceive and generate patterns as it tests hypotheses. "The brain is capable of processing many inputs at once and prefers multiprocessing. Hence, a slower linear pace reduces understanding" (Caine & Caine, 1997).	Teachers should accept attempts and approximations as children take risks to generate hypotheses, for instance with invented spelling, cross-checking in reading when coming to an unknown word, and in writing texts from a differing perspective or genre.
Response		
Exchanges between the child, teacher, and more capable peer help the student to adapt, modify, and extend learning.	"Every thought we think, every move we make, and every word we say is based in the electrical and chemical communication between neurons" (Wolfe & Brandt, 1997).	Specific feedback from the teacher and peers should be provided as children demonstrate their learning. Responses should be given without judgment, and time should be given for modifying and adapting their learning. Time for celebrations of learning through demonstrations to peers as with the Author's Chair help to extend learning for peers.

drites. Many of our children entering kindergarten are from disadvantaged socioeconomic environments in which a single parent, working and living in below-poverty circumstances, may not be capable of providing her children with a rich, stimulating home life. Extreme examples of children being raised in unhealthy environments indicate that the brain becomes "hardwired" and learning a language and important concepts become increasingly difficult. The brain requires external stimulation. The more it receives, the more diverse the branching of the dendrite and the greater number of synaptic connections. This is particularly true during the first few years of life in which the brain is expanding and developing at a heightened rate. It is critical at this time that the child is exposed to developmentally appropriate practices (Bredekamp & Copple, 1997, Rushton & Larkin, 2001). The aforementioned example of students reading and studying about pollution demonstrates this difference. Those students who read and discussed numerous informational books, experienced several field trips, wrote about their experiences, initiated a school-wide recycling program, and became involved in community service projects were stimulating different portions of the brain, building more dendrites, and linking more neurological pathways than would occur with direct instruction using a science textbook.

Condition of Learning: *Demonstration*
Brain Principle Two: *The brain changes as a result of experience.*

Equally important to the notion of immersion is what Cambourne coins demonstration. This is the physical teaching of a lesson, or a model example of what the teacher wants the students to learn. Learners of all ages require a model, or as he notes, an "action or artifacts" to help the learner observe or experience an intended outcome. In the area of literacy, children require numerous examples of how literacy relates to their world. Demonstrations need to be meaningful and relevant to a child's life, not just an abstract concept beyond the student's grasp. Cambourne suggests that we focus on the invisible processes and verbalize how and what we are thinking as we teach, that is, making explicit the process that makes reading possible. Further, he suggests that the concept of demonstration is generalized to all learning. Each day—while at home, on the way to school, and during their time at school—children experience countless demonstrations. It is our job as educators to help connect for the student the various mental processes that they are experiencing throughout their day as they are exposed to these demonstrations.

The second brain principle indicates that the brain changes physiologically as a result of experience. The

"Hey, Carol! What ya doing? Where are you going today?" *"Hello, Jenna. I don't know yet. I can't make up my mind . . . where are you going?"*	Immersion
"Well, yesterday I went to the science center and worked with my group on the landfill experiment. Have you been there yet? No? Oh, well, it's real cool. When you get it finished, it looks just like the landfill we visited last week. Hmmm, I think I'll go and feed the ferret. I love playing with him. Spiffy (the ferret) needs a bath, and it's my group's responsibility this month. See ya!"	Demonstration
"Hey, Carol! What' up?" *"Hi, Todd, I'm trying to figure out where I want to go this morning. My tracking sheet is pretty full. I've already been to the publishing center three times this week, the cooking center twice – those scallop things were awful, but peeling the shrimp was cool. I've also been to computer. Do you think Mr. Rushton will let us go four times to the publishing center? I want to finish publishing my book, but if I follow*	Engagement
this tracking sheet, I can't go again." *"I don't know Carol. Mr. Rushton said we could only go there three times this week, but . . ., ask him, or put it in the suggestion box. Then we could talk about it during our next class conference. Have you watered your plant yet? Mine's looking wilted. Looks like Mr. Rushton has another project going over there. What is it?"*	Expectations
"I think it's the class newspaper that we are supposed to be making. You know what? I wish he'd get over Kenny G. That music is so old!" *"[Derrick} Hi, Carol and Todd. Todd, do you want to go over to the carpentry corner? I want to make a satellite for my homework project. Are you guys ready for the sleepover Friday night? Can you believe that . . . a sleepover . . . right here at school! My Mom thinks Mr. Rushton is crazy! I'm gonna' stay up all night. I hear*	Responsibility
we're gonna' have a talent night, too." *"[Todd] I can handle the sleep over. It's the trip to the wastewater treatment center I don't want to go on. I hear it really stinks there!"* *"[Carol] I thought the dump, oops, landfill, was going to smell, too, but it was really clean. Maybe the wastewater treatment center won't be so bad after all. Have*	Employment
you guys made your landfill yet? It's actually pretty neat. Don't tell Mr. Rushton I said that! What's the writing assignment for the day anyway? Probably something to do with pollution, no doubt. Hey, no one is on the reading loft. Mr. Rushton said we could eat our snacks anytime. I wonder if he'll let me eat mine on the loft. See ya." *"Bye, Carol. I'm gonna' write in my journal how our landfill in our desks are overflowing (the space in which the students normally put their books was converted into landfills) and how the garbage is spilling out onto the floor, which is supposed to*	Approximation
be the ocean, and how all the fake fish are now dying! I think the janitor hates us. Mr. Rushton told him not to clean our room until we finish this unit on pollution. I guess he made his point. Look at all that mess on the floor! And some of the fish are disappearing! When I'm finished writing this up, I wonder if he will let me put it in the class newspaper. I will need someone to edit my first draft. Will you help me, Carol?"	Response

Fig. 1. Dialogue of third graders in a constructivist classroom.

brain literally changes and grows with each experience we have. As the teacher performs new demonstrations, the child's senses are activated, which in turn stimulates a specific portion of the brain. New dendrites are formed daily, "hooking" new information to prior experiences. The brain automatically searches out and attempts to place new stimuli to existing neurological pathways. Educators often refer to this as "scaffolding" (Applebee & Langer, 1983). When a child is experiencing something for the first time, for instance a 4-year-old sees, touches, and experiences a new animal, the brain attempts to connect the incoming sensory stimuli to existing neurological pathways. If none exist, then new dendrites will need to be formed. 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 & Brandt, 1998). Piaget and Inhelder (1969) discovered different time frames in a child's life when certain concepts were more readily understood and adopted into the child's learning. Today, we understand this better from a neurological developmental perspective. It is our job as educators to provide appropriate demonstrations for the child to experience learning.

The conversation in Fig. 1 also highlights the principle of demonstration. The teacher of that classroom has created a learning environment in which several demonstrations are going on simultaneously (the creation of a class newspaper, the landfill project, and classroom pollution spilling onto the floor/ocean killing the "fake fish"). Demonstrations can also take on the form of a teacher modeling part of the writing process or in the delivery of a novel science experiment.

Condition of Learning: *Engagement*
Brain Principle Three: *Each brain is unique. Lockstep, assembly-line learning violates a critical discovery about the human brain.*

Immersion and demonstration are important aspects of the learning process; however, it is when the student becomes actively engaged in the demonstration itself that learning is increased. Early childhood teachers have understood this concept for years, often providing real-life sensory and activity-based learning so as to stimulate as many of the senses as possible (Bredekamp & Copple, 1997). When students are able to engage in and take responsibility for their learning, a sense of empowerment often follows. Stimulating experiences help trigger a variety of neurons and create complex connections among the various regions of the brain. As the student sees, feels, and experiences modeled demonstrations of a lesson, artifact, or some action, the brain maps out this experience in a unique manner. Various parts of the brain are activated at once. For instance, when the aforementioned children were reading and discussing how to make landfills, their occipital lobes (the part of the brain that deals with vision), were engaged and activated as well as the motor cortex (picking up the materials, holding a book, and/or reading aloud) and the frontal cortex, as students attempt to make sense and consider the impact of pollution on the planet. Each of the four lobes (frontal, parietal, occipital, and temporal) work as a collective whole to understand, interpret, and assimilate the incoming stimuli.

Cambourne's third stage or condition of learning, engagement, is perhaps the most crucial part of the learning process. He suggests that engagement begins once the learner believes that there is a personal investment or purpose for them (i.e., seeing the value of reading or writing for itself, other than because that is what is required at school). As the child begins to see that there is a personal investment in the learning process, her attention to the subject at hand increases, and more importantly, she begins to engage in and become an active participant in the demonstration itself. Thus, the child learns best once she is engaged in the demonstration, and this happens when she sees a personal benefit to herself. The conversation in the previous example among the third graders provided numerous examples in which the students were engaged with their learning. For example, they used both a planning board (outlining the various centers around the room), tracking sheets (individualized sheets indicating what centers they need to attend), and made their own decisions regarding the choice of centers they desired to attend. Their learning environment provided a wide range of opportunities for them to talk, share, explore, and play. The centers provided choices to meet their individual needs as no two children nor two children's brains are the same. Rushton and Larkin (2001) describe these differences of learning succinctly:

> 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 [sic]. In truth, there are no homogeneous groups of children; as no two children are the same, no two brains are the same. (p. 29)

Conditions of Learning: *Expectations and Responsibility*

Brain Principle Four: *Emotions, learning, and memory are closely linked as different parts of the brain are activated in the learning process. Positive emotions drive attention, which in turn drives both learning and memory.*

Educators have a powerful influence on how students perceive the learning process and whether or not they can achieve certain outcomes. Setting realistic expectations and creating opportunities for the child to come responsible for their education are two key elements in the overall learning process. Too little expectation and not enough responsibility given to the student can cause apathy toward learning. Conversely, too high an expectation can cause the student to become frustrated. Cambourne (1995) believes that expectation is a core component of any classroom. He states, “Expectations are essential messages that significant others communicate to learners. They are also subtle and powerful coercers of behavior” (p. 185). Most parents expect their children to learn to speak and often flood their children’s early attempts with numerous praises. Elementary school teachers who set high expectations believe that their students will develop as readers and writers, so they provide them with various opportunities to engage and practice skills daily in a low-risk supportive environment (Desjean-Perrotta, 1996).

The brain’s emotional center, the amagyada, is tied to the brain’s ability to learn. Emotions, learning, and memory are closely linked, as different parts of the brain are activated in the learning process (Jensen, 1998). Caine and Caine (1997) believe that positive emotions drive attention, which in turn drives both learning and memory. They suggest that high levels of stress, or a perceived threat to the child, will inhibit learning. It is the brain’s principal job to ensure survival, and thus has been its role for thousands of years, with or without formal education. The amygdala first checks all incoming sensory information 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. Various chemicals released into the body can have a profound effect on the learning process. Responding to a feared signal (either real or perceived) the student’s body may release the hormone cortisol into the body. Too much cortisol short-circuits the cells in the hippocampus (the portion of the brain that deals with memory). Once this occurs, it may be difficult for the student to organize her thinking and memory. Hence, memories may lose their context and become fragmented (Wolfe & Brandt, 1998).

Setting realistic expectations for all children is an important component of the learning process. Rushton and Larkin (2001) suggest that “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” (p. 29).

We believe that all educators are responsible to co-create with their students an inviting learning environment that empowers the students to want to learn. This can be done by creating a relaxed atmosphere, one in which threat is absent. It is important to discover the balance between having the students feel safe and accepted in order to attend to the curriculum and yet interested and challenging to stimulate inquisitiveness and the excitement to learn.

Cambourne’s fifth condition of learning refers to the student’s innate ability to take responsibility for his learning. When teachers provide opportunities that allow students to have choices and make decisions about their learning, student learning is often increased. In part this is due to an increase in self-efficacy (Bandura, 1998). Again, the release of serotonin and other chemicals in the body help stimulate a sense of well-being, which indirectly increases the desire to want to learn. However, there is a fine line between “feeling too good” and creating a sense of apathy. Although Cambourne applies the condition of responsibility (having choice) to the acquisition and development of language, it is our belief that providing choice and giving responsibility to the student is a vital aspect of the overall learning process. Cambourne (1995) states:

> Learners are able to exercise this choice because of the consistency of the language demonstrations occurring in the everyday ebb and flow of the human discourse. Such demonstrations (a) are always in a context that supports the meanings being transacted; (b) always serve a relevant purpose; (c) are usually wholes of language; and (d) are rarely (if ever) arranged according to some predetermined sequence. (p. 185)

The conversation that took place in the third grade classroom provides examples whereby students took responsibility for their learning. They were required to make a number of choices throughout the day and take responsibility for their education. Each child was provided with a planning or tracking sheet that outlined both the required and optional, negotiated activities that had to be accomplished in a set period of time. These activities were negotiated according to each student's abilities. Each individual student's needs are unique, as are their abilities. Setting the same criteria for all students is not appropriate. Differentiated curriculum requires the teacher to know the individual needs of their children and to plan accordingly.

Caine and Caine (1994) state that memory is affected by attention that is driven by emotion. We suggest that students who are emotionally invested in the learning process, when provided reasonable choices and expectations and given important responsibilities in the day-to-day routine, will move more information to long-term memory and build more dendrites as they assimilate information that interests them. At a neurophysiological level, the brain interprets external stimuli, which often trigger various electrochemical reactions throughout the body. Various neurotransmitters, such as dopamine and serotonin as well as 60–100 others, will create positive or negative emotional experiences. This, in turn, will have an impact on the child's ability to focus and ultimately aid in long-term memory.

Condition of Learning: *Employment*
Brain Principle Seven: *When a child is engaged in a learning experience, a number of areas of the brain are simultaneously activated.*

> *"We got it!" exclaimed Jessie and Sarah as they thought about the math problem. Mrs. Zickafoose handed out one more M&M for the next math problem and turned around.*
>
> *"Now share your steps to solve the problem with your shoulder partner." As the students began to discuss their reflections, the teacher could almost see them constructing new pathways in their brains.*
>
> *"That's not the way I did it," said Jessie. "Here, let me show you."*
>
> *"Oh!" said Sarah, as she watched Jessie cautiously walk her through the math problem.*
>
> *"Hmmm. That makes it easier."*
>
> *Mrs. Zickafoose then directs the students, "Now, go back with your partner and list the steps that you took to solve the problem."*
>
> Feverishly, Jessie and Sarah analyzed each step and captured it on paper. With a raise of her hand, Mrs. Zickafoose gathered the children's attention and asked a simple question. "How could we solve this problem? This time, Sarah eagerly raised her hand.

This multilayered example embodies the essence of Cambourne's concept of employment. Inside this condition, Cambourne suggests that as a consequence of discussion and personal reflection, children will construct new knowledge. This discussion creates an "intelligent unrest" or "disequilibration" (Piaget & Inhelder, 1969) where the children search for a true understanding to help them "scaffold" their next learning step. Paired discussion, team brainstorming, individual reflection, and time for application all help mirror the classroom applications of the employment cycle.

Through the eyes of the brain, the employment condition echoes the need to see learners as unique individuals and to allow students to process information in a social setting. Both Vygotsky (1979) and Caine and Caine (1997) propose that humans need to socialize and relate to others in order to enhance learning. Additionally, it is vital that teachers allow students process time to construct new knowledge based on meaningful experiences and discussions.

Condition of Learning: *Approximation*
Brain Principle Six: *The brain is designed to perceive and generate patterns.*

> *The morning rush begins. The children come into the classroom ready for a full morning of reading and writing. We begin Monday mornings with a weekend report. The children are busy making a mind map of the events of their weekend. Rosalba goes straight to her writing. She skips the mind map as she knows what she wants to write. As she pours out her feelings onto the blank page, she doesn't appear to take any sort of mental break. After 15 minutes of industrious work, she walks over to the "No Excuse Word Chart" with highlighter in hand. The chart is filled with words that have been studied for meaning, spelling pattern, or are just words that are expected to be spelled correctly. She slowly marks through all the no excuse words that she may have missed while pouring her experiences on paper. Rosalba then follows up to the spelling tub that has small self-adhesive notes inside. Walking briskly back to her seat she copies one misspelled word per sticky-note. Her glance toward the word wall is hard and studious as she sticks each note on the side of the paper. Finally, she is ready for an editor.*

Cambourne seventh Condition of Learning suggests that children need to take risks, to test out hypotheses, and make approximations as they discover the overall content. This is an important and vital part in their learning process. The acceptance of Rosalba's misspellings is temporary. Each month, the "no excuse" wall expands as the expectations of the child increase. Each approximation ought to be handled with genuine acceptance and encouraged whenever possible. Accepting her misspellings before the editing process allows Rosalba to focus on the content of the message. Meanwhile, it sends the message to her that the experience itself is valuable. By accepting this raw writing, the emotion and passion of the experience is transferred from her heart to the paper.

Each child's brain is unique. Built upon their life experiences, they are patterned to accept and process the world differently. Cambourne's concept of approximation allows for this uniqueness as the teacher provides feedback systems to guide, scaffold, and challenge a child's attainment of the skill. Word walls, sticky bins, editing process, peer editing, and conferencing all allow for the child to receive feedback as needed to strengthen his understanding. A teacher accepts the child's unique expression of the skill or concept and provides guidance with specific feedback to support the learning process. The classroom environment that permits and supports approximations provides each unique brain with the challenge of approaching a new concept and the feedback necessary to understand and further develop that concept.

Condition of Learning: *Response*

Brain Principle Seven: "*Every thought we think, every move we make, and every word we say is based in the electrical and chemical communication between neurons*" (P. Wolfe interview by D'Arcangelo, 1998).

> *Mrs. Zickafoose is sitting with several of her second graders during writer's workshop.*
>
> *"I'm confused. When you said you read that you were outside in your story, I thought you were having breakfast with the alien. Mrs. Zickafoose, Does that make sense?" Mrs. Zickafoose quietly waited for other second-grade students to respond to Maria, who was sitting in the Author's Chair.*
>
> *"No, that makes sense to me. The alien transported her outside. Right, Maria?"*
>
> *"Yes, that what I was trying to say, but maybe I should include something about how I was transported to the garden outside," said Maria.*
>
> *Mrs. Zickafoose responded, "Those were most helpful ideas. I like how everyone is offering feedback that will make the story even better. Does anyone else have other comments?*
>
> *Michael jumped in saying, "I loved the way you described the alien's face and antennae. It was just like the picture you drew."*

The second-grader's dialogue in Mrs. Zickafoose's classroom represents one form of what Cambourne refers to as response. Each day, Mrs. Zickafoose's students gather together, either in a large group setting or in smaller literature writing groups, in order to share their written works. These writer's workshops let the authors hear their own writings being reflected by their audiences. Students are encouraged to respond with suggestions, compliments, and comments regarding the shared text. Cambourne suggests that it is critical for all learners to receive feedback from an outside, knowledgeable, significant other. As Cambourne (1995) states, it is important that the teacher create a trusting environment and that the response be "relevant, appropriate, timely, readily available, with no strings attached" (p. 33).

Throughout this article we have stressed the importance of creating a nonthreatening environment, one that creates trust, risk taking, and that urges the students to participate in a real way in their education. We feel that this last brain principle is critical for teachers to fully understand and learn about. As the brain digests, processes, and takes in information from external stimuli (response), a series of complex chemical–electrical reactions take place involving over 100 neurotransmitters. Nerve cells in the various portions of the brain are constantly receiving, processing, and sending signals from one nerve to another. Although nerve endings do not actually touch, the electrical impulse, firing of one nerve to another (called synapses) transfers various chemicals and thus creates meaning. The manner in which the response is provided will impact how the student learns. Providing positive feedback to a child during the course of their learning is a necessary investment in the educational process.

CONCLUSION

In a constructivist, brain-based learning environment, the role of the teacher would be to act as a facilitator or guide to create meaningful opportunities and situations so that the children can explore, ponder, and actively engage in their learning. Consequently, a teacher may become involved in negotiating social interactions that permit students to build and test knowledge within the social context of their classroom. Further, elementary and early childhood educators believe that learning is maximized in a child-centered learning environment; one that promotes the creativity and unique learning styles of the individual learner (Rushton, 2001). Those of us who advocate and teach a constructivist philosophy attempt to build, construct, and cocreate meaning, and subsequent learning and knowledge, through an interaction or engagement with the environment and with the student. Underpinning our teaching is the recognition of each unique individual's learning styles and talents.

The 1990s were coined the Decade of the Brain. During this time an explosion of articles, research, and inferences were drawn to support educational practices. The principles outlined in this article are a compilation of some of those researchers and their discoveries. It is also clear that with each passing month, new and exciting understandings about how the brain functions and how we as educators can maximize the brain's potential are being revealed. As Wolfe and Brandt (1998) aptly state, "the brain is essentially curious, and it must be to survive" (p. 13). The dialogues and examples shared in this article among the different grades and children provide examples of important elements in the classroom that help foster a brain-based, developmentally appropriate learning environment as well as support Cambourne's Conditions of Learning. In each of the various scenarios, the children were engaged in an enriched learning environment that fostered what educators call "high involvement–low stress" activities. Many of the experiences involved real life, "hands-on," thematically based activities that were oriented to solving problems. Additionally, these children were using many of their senses and various intelligences (Gardner, 1993) while learning through social dialogue, active listening, physical movement, reading, and writing. They were engaged in activities that allowed them to make important decisions and choices regarding what they were learning as individuals, in pairs, and in small cooperative groups. It is easy to imagine the brain's synaptic networks making connections as the students touch, think, discuss, eat, and interact with each other. In these enriched environments, the child had multiple opportunities to be physically, socially, and mentally immersed in their learning.

REFERENCES

Applebee, A. N., & Langer, J. A. (1983). Instructional scaffolding: Reading and writing as natural language activities. *Language Arts*, *60*, 168–175.

Baines, L. A., & Stanley, G. (2000). We want to see the teacher: Constructivism and the rage against expertise. *Phi Delta Kappan*, *82*(4), 327–330.

Bandura, A. (1998). *Self-efficacy*: *The exercise of control*. New York: Freeman and Company.

Bredekamp, S., & Copple, C. (1997). *Developmentally appropriate practice in early childhood programs*. Washington, DC: National Association for the Education of Young Children.

Caine, R. N., & Caine, G. (1994). *Making connections*: *Teaching and the human brain*. New York: Addison-Wesley.

Caine, R. N., & Caine, G. (1997). *Education on the edge of possibility*. Alexandria, VA: Association for Supervision and Curriculum Development.

Cambourne, B. (1988). *The whole story*: *Natural learning and the acquisition of literacy in the classroom*. New York: Ashton Scholastic.

Cambourne, B. (1995). Towards an educationally relevant theory of literacy learning: Twenty years of inquiry. *The Reading Teacher*, *49*(3), 182–192.

Cambourne, B. (1999). Conditions for literacy learning: Turning learning theory into classroom instruction. A minicase study. *The Reading Teacher*, *54*(4), 414–429.

D'Arcangelo, M. (1998). The brains behind the brain. *Educational Leadership*, *56*(3), 20–26.

Desjean-Perrotta. (1996). On becoming a whole-language teacher. *Young Children*, *52*, 11–20.

Dewey, J. (1938). *Experience and education*. New York: MacMillan.

Diamond, M., & Hopson, J. (1998). *Magic trees of the mind*: *How to nurture your child's intelligence*, *creativity*, *and healthy emotions from birth through adolescence*. New York: Penguin Putman.

Fosnot, C. (1996). *Constructivism*: *Theory*, *perspectives*, *and practice*. New York: Teachers College Press.

Goldman, Daniel (1995). *Emotional intelligence*. New York: Bantam.

Hausfather, S. (2001). Where's the content? The role of content in constructivist teacher education. *MDIUEducational Horizons*, *80*(1), 15–19.

Hausfather, S. J. (1996). Vygotsky and schooling: Creating a social context for learning. *Action in Teacher Education*, *18*(2), 1–10.

Jensen, E. (1998). *Teaching with the brain in mind*. Alexandria, VA: Association for Supervision and Curriculum Development.

Jensen, E. (2001). Fragile brains. *Educational Leadership*, *59*(3), 32–36.

Leinhardt, G. (1992). What research on learning tells us about teaching. *Educational Leadership*, *49*(7), 20–25.

Lincoln, M. (2001) Constructivist learning with primary sources. *Book Report*, *20*(3).

Noddings, N. (1990). Stories in dialogue: Caring and interpersonal reasoning. In C. Witherell & N. Noddings (Eds.), *Stories lives tell*: *Narrative and dialogue in education* (pp. 157–170). New York: Teachers College Press.

Phillips, D. C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher*, *24*, 5–12.

Piaget, J. (1954). *The construction of reality in the child*. New York: Basic Books.

Piaget, J., & Inhelder, B. (1969). *The psychology of the child*. New York: Basic Books.

Prawat, R. S. (1996). Constructivisms, modern and postmodern. *Educational Psychologist*, *31*(3/4), 215–225.

Rushton, S. (2001). Applying brain research to create developmentally appropriate learning environments. *Young Children*, *56*(5), 76–82.

Rushton, S., & Larkin, E (2001). Connecting developmentally appropriate practices to brain research. *Early Childhood Education Journal*, *29*(1), 25–33.

Saunders, W. L. (1992). The constructivist perspective: Implications and teaching strategies for science. *School Science and Mathematics*, *92*(3), 136–141.

Sylwester, R. (1997). The neurobiology of self-esteem and aggression. *Educational Leadership*, *54*(5), 75–79.

von Glasersfeld, E. (1995). A constructivist approach to teaching. In L.P. Steffe & J. Gale (Eds.), *Constructivism in education*, *3*(15), Hillsdale, NJ: Lawrence Erlbaum.

Vygotsky, L. (1967). Play and its role in the mental development of the child. *Soviet Psychology*, 12, 62–76.

Vygotsky, L. S. (1978). *Mind in society*: *The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wolfe, J., & Brandt, R. (1998). What we know from brain research. *Educational Leadership*, *56*(3), 8–14.

Wood, T. (1995). From alternative epistemologies to practice in education: Rethinking what it means to teach and learn. In L. P. Steffe & J. Gale (Eds.), *Constructivism in education* (pp. 331–339). Hillsdale, NJ: Lawrence Erlbaum.