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PHYSICAL ACTIVITY

Active Bodies/Active Brains: The Relationship Between Physical Engagement and Children's Brain Development

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Abstract

Educators often struggle daily with the issue of how to engage students for learning. Many instructional strategies are devoted to the concept of engagement to keep students interested and on task to enhance learning, but defining the term is difficult. Engagement may involve a combination of terms that relates to the effort of students when they devote themselves to purposeful activities (Krause & Coates, 2008). Advocates of physical engagement have known for years that movement enhances learning, but what has been missing is the research to support this belief. An increase in brain research now provides a definitive link connecting movement with the enhancement of learning. The purpose of this paper was to examine the relationship between physical engagement and the development of the mind–body connection, how physical engagement enhances that development, and the current research in the field that supports the construct.

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Educators often struggle daily with the issue of how to engage students for learning. Often what is relevant or interesting for one student is the opposite for another. Many instructional strategies are devoted to the concept of engagement to keep students interested and on task to enhance learning, but defining the term is difficult. Engagement may involve a combination of terms that relates to the effort of students when they devote themselves to purposeful activities (Krause & Coates, 2008). Schaufeli (2013) stated that the term *engagement* involves three basic elements: physical, emotional, and cognitive. A single definition for engagement is not apparent, but the following definition represents an aggregation of the literature. "Engagement is seen to comprise active and collaborative learning, participation in challenging academic activities, formative communication with academic staff, involvement in enriching educational experiences, and feeling legitimated and supported by university learning communities" (Coates, 2007, p. 122).

A single component of the concept of engagement is active learning, which is the process of engaging students in the learning process through participation and reflection (Prince, 2004). Active engagement refers to the joint functioning of motivation, movement, conceptual knowledge, cognitive strategies, and social interactions in learning activities (Guthrie & Anderson, 1999). Rather than passively receiving the information, the student combines academic content with physical movements and skills to enhance learning. Research in this area supports the use of active engagement to enhance learning (Donnelly & Lambourne, 2011; Shephard & Trudeau, 2005). Teaching that emphasizes active engagement helps students process and retain information that may lead to higher student achievement. An old Chinese proverb that originated with Xun Kuand, a philosopher that lived from 312–230 B.C., is applicable: "Tell me, I forget, show me, I remember, involve me, I understand."

The term *physical engagement* will be used in this paper to combine the various types of active engagement that occur in the educational arena including the areas of recess, physical education/activity, play, and sport. The author understands that the individual terms have specific intents, but there is an overlapping context in using movement to enhance development. Each term involves a process that is carefully woven into the other to elicit a special type

of physical engagement that benefits the development of the whole child. As pressure continues to increase for students to perform well on high-stakes tests, educators will look to find ways to focus more time on academic learning for which physical engagement aids in developing active bodies and active minds.

Quality physical education programs provide a mixture of play, free time, physical enhancement, and structured teaching. A child who uses his or her body to form different letters of the alphabet works on different cognitive, social, and physical components to enhance development. The purpose of this paper was to examine the relationship between physical engagement and the development of the mind–body connection, how physical engagement enhances that development, and the current research in the field that supports the construct.

Development of the Mind–Body Connection

Our evolutionary ancestors, as a way of life, were used to walking up to 12 miles/day (Medina, 2008; Ratey, 2008). This pursuit for fitness was driven by a desire to survive through hunting and fishing. During most of our evolutionary history, very healthy bodies supported the development of our brains (Medina, 2008). Advances in modern society have pushed civilization into less activity with more opportunities and excuses to be stationary. The health benefits of physical activity are evident to most people, but despite this knowledge, most people worldwide are less active (Watkins, 2014). Individuals today are used to sitting in a classroom or office for 8 or more hours a day. Globally, only 1 in 3 people gets the recommended levels of physical activity, and this lack of physical activity contributes to chronic diseases (World Health Organization, 2011). Movement is like "cognitive candy" to our brains, and our brains can make a comeback: All we have to do is move (Medina, 2008).

The history of the mind–body connection can be traced back to ancient Greece and Rome when Hippocrates first combined science and philosophy to explain human behavior. Evidence of an essential link between the mind and the body originated with research from Leiner, Leiner, and Dow (1986), who proposed a new concept of how the cerebellar capabilities may contribute to mental skills. Leiner et al.'s (1986) research reconceptualized the cognitive map, which demonstrated the means by which people process their envi-

ronment, solve problems, and use memory (Richardson, Montello, & Hegarty, 1999).

Hannaford (2005) found evidence in brain scans that shows children learn best when they are active and moving because movement stimulates the neurons and electrical wiring that facilitate children's ability to take in information and learn. Part of this important link was established when researchers traced a pathway from the cerebellum to parts of the brain involved in memory, attention, and spatial perception (Jenson, 2000a). Researchers have found that the part of the brain that processes movement is the same part of the brain that processes learning.

President George W. Bush called the 1990s the decade of the brain (Jones & Mendell, 1999). Scientists learned more about the brain and how it worked during this span of years than they had learned in the previous 100 years. The year 1995 began the avalanche of studies on the effect of exercise and the brain. Scientists (Medina, 2008; Ratey, 2008) in the area of brain research have documented substantial evidence of a MAJOR connection between physical engagement in any form and the brain's performance. Medina (2008) looked at the role of exercise and how it affects learning with the basic premise that if a person wants to improve thinking skills, he or she must move. Sattelmair and Ratey (2009) discussed the evidence that physical activity improves academic performance, thus the need to reform current physical education programs. Educational practitioners are also weighing in on the issue and finding practical ways to use brain-based learning in the school environment (Jenson, 2000a; Moore & Sellers, 2014; Tokuhama-Espinosa, 2010; Wolfe, 2010).

Physical education, movement, drama, and the arts can all be used in an integrated theme for learning. Classroom teachers can have kids move in the classroom to learn academic content (brain breaks), and physical education teachers can include academic concepts in the teaching of physical activity (integrated lesson ideas). Educational systems continue to add various curricula to enhance intelligence, improve reading, encourage girls in math and science, and diversify education (National Association for the Education of Young Children & National Association of Early Childhood Specialists in State Departments of Education, 2003; Frede & Ackerman, 2007). To offer these additional curricula, administrators may push to elimi-

nate physical engagement from the school day. Anything deemed as a nontraditional subject such as art, music, recess, or physical education might be deemed unnecessary. Recent brain research suggests that this is a mistake, because the cerebellum is a virtual switchboard of cognitive activity (Medina, 2008) that can affect learning and development in a variety of ways.

Support for increased physical engagement now includes pediatricians (Limperopoulos et al., 2007), kinesiologists (Jenson, 2000a), and neuroscientists (Hannaford, 2005). Many schools are reducing physical engagement sessions because of time constraints, but some studies (Castelli, Hilman, Buck, & Erwin, 2007; Caterino & Polak, 1999; Wilkins et al., 2003) have linked activity with increases in cognitive development, and these studies will be reviewed in the research section below.

How Does Physical Engagement Facilitate Brain Development?

Researchers (Hannaford, 2005; Jenson, 2000b) have found that the brain uses the same connections to move that are used to process learning in reading, writing, and math. They have used electrode connections placed on a child's head and an elaborate computer program to map the areas of the brain being used during activities such as reading, calculating math, and physical engagement. They found with the different activities that certain areas of the brain light up, indicating activation of the brain. The areas that light up when the child reads or calculates math are the same areas that light up when the child is engaged in movement activity (Jenson, 2000b). The results provide insight into the connection between cognitive areas of the brain and how physical engagement can enhance learning connections.

Play theorist Brian Sutton-Smith (1997) believes that children are born with the capacity to develop a huge neuronal network that will die if not used. While children are physically moving they are developing neurological foundations that assist with problem solving, language development, and creativity. Physical engagement assists children in learning how to relate to others, adjust their muscles, and think abstractly. Through physical engagement, children develop a general mind-set of how to string bits of information together to

form solutions to problems and actually learn how to learn. In the physical realm, it is easy for children to understand that the more they practice a basketball shot or rehearse a dance performance, the more their skills improve. Students can also apply a similar principle in the cognitive area to understand that the brain responds in the same way. When a learner goes over multiplication facts or rereads confusing parts of a book, the brain gets better at processing this information. The two areas of learning can be combined for physical engagement so that the student practices a basketball shot five times and multiples the total by 2, 3, 4, 5, and so forth. When physical engagement and cognitive development are combined, the student increases the neurons that grow and connect to other neurons, so these neurons get more efficient at sending one another signals.

The ages between 3 and 11 are a time of rapid growth in multiple ways (social, intellectual, emotional, and physical). Brain activity during this time occurs at more than twice the rate than it does in the adult brain (Moore & Sellers, 2014). New synapses continue to form throughout life, but never again will the brain be able to master new skills or adapt to setbacks so easily (Ratey, 2008). Learning requires the creation of new neural connections, but the previous connections that have not been used are eliminated. It is a use it or lose it situation when it comes to neural connections. Every time a person moves in an organized manner, full brain activation and integration occurs and the door to learning opens naturally.

There is no doubt that childhood is about learning and the brain can develop without movement and physical engagement, but consequences may develop. Evidence exists that the removal of one or more sensory experiences early in life affects the ability of the brain to develop basic foundations needed for learning. Prescott's (1971) research on deprivation indicates that during the sensitive period of brain growth and development, conception to approximately 18 months of age, movement is as critical as good nutrition.

Basic neuroscience describes how the brain functions and grows as a result of physical engagement. The brain needs the basic elements of fresh oxygenated blood and water to be able to function effectively (Jenson, 2000a). The brain requires more oxygen than any other organ of the body does. The brain makes up only one fifteenth of the weight of the body, but it uses one fifth of the oxygen in the body (Blaydes, 2000). Oxygen is essential for learning. Movement

and physical engagement enable oxygen to be carried to the brain for efficient functioning and learning. This presents a problem in the current organization of educational settings. Children do a lot of sitting each day in class. Blaydes (2000) found that while a person sits, 80% of blood pools in the hips after just 20–30 min. If the blood is in the hips and not enhancing the brain, then learning becomes more difficult without the fresh oxygenated blood.

Ayres (1972), Gardner (1985), and Montessori (1948/1973) all espoused the importance of movement to the learning process. If physical educators desire is to create the best foundations to enhance learning in the early years, then physical engagement can enhance this development (Greenough & Black, 1992; Shatz, 1992). Using movement to increase learning affects the child in both the classroom and the physical environment (Jenson, 2000b; Ratey, 2008). The more connections a person has, the better and faster he or she becomes at using the information, solving problems, and thinking. The bottom line is that when physical educators provide physical engagement opportunities for children, they are developing not only the physical component of the child, but also the cognitive component (Hannaford, 2005).

Research That Supports the Relationship Between Learning and Physical Engagement

At the 1995 Annual Society of Neuroscience Conference, over 800 participants listened as a panel presented nearly 80 studies that suggest strong links between the cerebellum, memory, spatial perception, language, attention, emotion, nonverbal cues, and even decision making (Thach, 1996). Now with the advent of neuroscience, researchers are dedicated to understanding and exploring the connections between the brain and learning (Hannaford, 2005; Medina, 2008; Ratey, 2008). The research summarized below quantifies the results of the neuroscience findings that broadly conclude that (a) engagement in physical activity is associated with academic achievement, (b) cognitive performance improves significantly when children engage in movement activity, and (c) many of the social and physical benefits of movement are associated with success in school. The following is a summary of the research that supports these relationships:

- Students with higher fitness scores also had higher academic achievement. In 2002 and subsequent years, fit kids scored twice as well on academic tests as did their unfit peers (California Department of Education, 2005).
- Increasing physical activity and fitness is a promising approach to enhance brain development and cognition in children (Kirk, Hillman, & Kramer, 2015).
- Researchers in various academic and medical fields (from kinesiology to pediatrics) did a massive review of literature of more than 850 studies on the effects of physical activity on school-aged children and found that physical activity has a positive influence on memory, concentration, and classroom behavior (Janssen & LaBlanc, 2004).
- The relationship between physical fitness and academic performance in 259 third and fifth grade students showed a strong association between aerobic fitness and performance on standardized testing, grades, and other measures of cognitive performance (Castelli et al., 2007).
- Students who received daily physical education and movement showed the rate of learning per unit of time does not appear to increase. Using longitudinal studies, Shephard and Trudeau (2005) concluded that when 14%–26% of the curriculum is allocated for movement activity, learning occurs more rapidly. This premise also provides support that lack of curricular time is not a good reason to deny physical engagement activities (Shephard & Trudeau, 2005).
- In the School Health, Academic Performance, and Exercise study (SHAPE) conducted in Australia, Dwyer, Coonan, Leitch, Hetzel, and Baghurst (1983) looked at changes in math, reading, and fitness scores among children who were randomly assigned to fitness, skill, or regular physical education classes. The academic achievement of the groups in math and reading was the same, despite that students in the experimental groups spent over 75 min/day in physical education. The results support the premise that spending more time in physical engagement does not have a negative influence on academics (Dwyer, Coonan, Leitch, Hetzel, & Baghurst, 1983).

- Increasing time in physical education does not negatively influence academic achievement, and decreasing time in PE (as many principals believe) will not ensure that children perform better (Wilkins et al., 2003).
- The quantity and quality of physical participation support implications for increased academic performance (Caterino & Polak, 1999; Shephard & Trudeau, 2005; Symons, Cinelli, James, & Groff, 1997).
- There is increasing evidence for the association between physical activity, cardiovascular fitness, fatness, and cognitive function during childhood and adolescence. Evidence also suggests that these variables are linked to academic achievement (Donnelly & Lambourne, 2011).

Conclusion

Schools are under enormous pressure to demonstrate effectiveness in meeting standards in the core subjects. Most schools are not aware of or have not responded in a positive way to the research that supports physical engagement and cognitive enhancement. Research shows that people grow new brain cells through physical engagement and activity (Blaydes, 2000). When people learn something new, they enhance the development of new neural connections. Hannaford (2005) stated that if people increase active physical engagement participation, they increase movement, and they can increase neural growth in the brain. The more connections people have, the better and faster they become at using the information, solving problems, and thinking. The bottom line is that when physical educators provide movement opportunities for children, then they are developing not only the physical component of the child, but also the cognitive component.

There is an abundance of research that shows the benefits of physical engagement during the early childhood years (Brown & Vaughan, 2009; Freund, 2013; Goldstein, 2012). Even though parents and teachers recognize the value that physical engagement may add to the child's development, opportunities for physical engagement continue to diminish (Kuh & Cooper, 1992; Welk, 1998). There are fewer spaces, inhibited freedom to roam outdoors, and decreased time in school for play, recess, and physical education class (Goldstein, 2012). The case for physical engagement is clear, but the

question that remains is, what will we do to ensure children get the physical engagement they need to learn and grow?

Physical engagement truly is enjoyable work for children as they develop and build cognitive brain connections. The more active their bodies are, the more active their brains will become, and physical engagement is a facilitator of that development. The brain is involved in everything a person does, and to ignore it is irresponsible. Hopefully, as new findings continue to substantiate this vital link, schools will begin to implement the findings to enhance learning for all children.

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