

Exercise and the Brain:

The Connection between Movement and Learning

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Abstract

Researchers have been looking at physical activity as a key proponent in the way we think and feel. Many claim exercise prepares your brain to learn. This mind/body connection has the potential to revolutionize the way we structure our classrooms, curriculum, and even schedules throughout the school year. The physiological foundation of the mind/body connection has been documented in many ways. The four approaches which target the question, can physical activity improve cognitive function, are: the relationship between physical education class and academic achievement; the connection between physical fitness and academic improvement; the correlation between outside class curriculum and improved learning; and the link between improved learning and activity within the classroom.

Introduction

Researchers have been looking at physical activity as a key proponent in the way we think and feel. Many claim, exercise prepares your brain to learn. Blood flow along with our body's chemical reactions “spark” the necessary components needed for optimal learning. This mind/body connection has the potential to revolutionize the way we structure our classrooms, curriculum, and even schedules throughout the school year. Putnam, Tette, and Wendt (2004) state, “The use of exercise as an intervention for at-risk students has a sound theoretical basis in the connection between the mind and the body”(p.25). The physiological foundation of the mind/body connection has been documented in many ways. Intense exercise not only improves behavior, it encourages the growth of the body's “neuronal infrastructure”.

Two recent initiatives mandated by the Federal Government may join forces to support the positive connection between movement and learning. First, the White House and Michelle Obama recently announced a far-reaching program designed to change the way children eat and play. The goal is to eradicate childhood obesity within one generation (*New York Times*, 2010). One third of American children and adolescents are obese or overweight (*American Heart Association*, 2010). Obesity has nearly tripled for children 2 to 5 years of age and youth 12 to 19 years of age over the past 30 years, and it has quadrupled for children 6 to 11 years of age. Second, the No Child Left Behind Act has recently lead to an accountability shake up as schools are letting teachers go, or even closing their doors due to “underachievement” scores. Other school districts throughout the nation could face the same hardships soon, as President Obama's \$4 billion federal school turnaround program, Race to the Top, is initiated (*New York Times*, 2010). Where is the connection? The connection is between the body and brain – exercise and

learning. In fact, one antidote to combat low achievement may just be physical exercise. Many individuals and organizations make this claim, however, the methods from which this connection is studied come from four different approaches (relationship between physical education class and academic achievement, correlation between fitness scores and academic achievement, connection between physical activity outside the classroom curriculum and academic achievement, and movement within the classroom linked to academic achievement).

The purpose of this paper is to review the literature surrounding the relationship between increased physical activity and academic achievement. I will begin with a brief explanation of the physiology of the brain followed by an in depth look at four approaches to this research in mind/body relationships: Approach #1 - relationship between participation in physical education class and academic achievement. Approach # 2 - correlation between physical fitness scores and academic achievement. Approach #3 - connection between physical activity outside the classroom curriculum and academic achievement. Approach #4 - movement within the classroom linked to academic achievement.

Zhao (1999) claims, “American education is at a crossroads” and “we need to change course” to maintain leadership in a rapidly changing world. It seems, in a competitive global economy, the desire to produce competent, intelligent, first class graduates has become a burning issue for many stakeholders. To achieve this, agencies may go to extreme measures to not only stay in the game, but ultimately win the contest. Government agencies are no exception - in fact, they may become our most unforeseen ally. When the antidote for low achievement becomes physical exercise, there may be a race to be the fittest nation in this global competition. Presently, there are programs specifically designed to incorporate physical activity into the

classroom. Will one size fit all? What other factors may be involved? Can schools financially afford the changes? How do we get school boards, parents, and even teachers to buy into the implementation of this improvement plan? These questions, along with others, will be addressed throughout the paper.

Method

Special attention was given to the quality of the literature as it related directly to research correlating physical activity and learning. Most research presented is in the form of quantitative measures while some is offered as qualitative. The literature cited in this paper was obtained through electronic searches using Marquette's Raynor Library (ERIC-Ovid, Journals, websites, Google, reviews and research articles). Other resources include: curriculum binder, books on education and brain-based learning, the New York Times, catalogs, class observations, American Heart Association, and the University of Illinois-Science Daily. The dates in which this literature were written, span from 1984 to 2010.

Summary of Literature

Physiology of the Brain

Ratey (2008a) explains how messages are carried throughout the brain via the junction between cell branches called the synapse (these do not touch each other). Connections work between branches by electrical signals sent across the gap in chemical form (electric to chemical and back to electric). Roughly eighty percent of this chemical (neurotransmitter) connection is carried out by glutamate and gamma-aminobutyric acid. The more often the process happens,

the stronger the attraction becomes. When the brain is called on to take in information, more glutamate is called to fire the connections. Brain-Derived Neurotrophic Factor (BDNF) are proteins that build and maintain the cell's circuitry – it's infrastructure. BDNF is in the brain's hippocampus which is related to memory and learning. (The hippocampus is stimulated during exercise which leads to a direct correlation to the part of the brain responsible for learning). BDNF, when “sprinkled” onto neurons in a petri dish, causes cells to automatically sprout new branches – this produces the same structural growth for learning. BDNF “improves the function of neurons, encourages their growth, and strengthens and protects them against the natural process of cell death” (p. 40). Brain-Derived Neurotrophic Factor is a crucial biological link between thought, emotions, and movement. “Gym class provides the brain with the right tools to learn, and the stimulation in the kids' classes encourages those newly developing cells to plug into the network” (p. 50). Smith (2010) concurs physical activity has a direct effect on brain cells. There are neurochemical changes that happen with exercise and there is an increase in production of BDNF which arouses the connection with neighboring brain cells, aiding in the growth of new brain cells.

Exercise maximizes your mind-set to improve alertness, attention, and motivation; it prepares and encourages nerve cells to bind to one another, which is the formula for logging into new information at the cellular level; and it stimulates the development of new nerve cells from stem cells in the hippocampus (Ratey, 2008a). Scientists are only beginning to tackle the question, “What is the ideal exercise plan?” Still, conclusions can be made in regard to studying while exercising. You cannot learn while exercising at high intensity because blood flow moves away from the prefrontal cortex, “hampering your executive function.” However, blood flow

shifts back almost instantly after exercise, making this the perfect time to work on a project that requires complex analysis and sharp thinking. “So if you have an important afternoon brainstorming session, going for a short, intense run during lunchtime is a smart idea” (p.54).

Evidence gathered from research conducted over the past few years imply that gains in children’s mental functioning, as a result of exercise training, are shown to be more on tasks when involved in executive functions (Tompsonski, Davis, Miller, & Naglieri, 2008). Executive functions occur when performing goal-directed actions in complex stimulus environments, in which components are constantly changing. These types of behaviors have been seen as important for children’s adaptive functioning for many years.

Relationship between Physical Education Class and Academic Achievement

The first approach to researching the mind/body relationship involves analyzing the connection between having physical education class and academic performance. Tremarche, Robinson, and Graham (2007) conducted a study to reveal the impact of increased quality Physical Education time on Massachusetts Comprehensive Assessment System (MCAS) standardized scores. The study examined the cognitive and physical benefits of movement, physical activity, and exercise. This study implies students who receive more hours of physical education can score higher on particular subject areas of the MCAS test. This study can offer useful information to educators and administrators who may be facing the decisions regarding program reduction (if the elimination of physical education is considered) due to the need for increasing daily academic time to aid in the improvement of test scores. Others have used similar comparison analysis of physical education class and achievement. Coe, Pivarnik,

Womack, Reeves, and Malina (2007), for example, noted the effects of physical education class enrollment and physical activity on academic achievement in middle school students. Students were randomly assigned to physical education during either first or second semesters. Moderate to vigorous physical activity (MVPA) outside of school was assessed by asking each child about his or her previous day's activities for three consecutive days. Academic achievement was assessed using grades from four core curricular classes and standardized test scores (Terra Nova percentiles) - Terra Nova scores are derived from a national standardized test, which consists of multiple assessments of reading or language arts, mathematics, science, and social studies. Although academic achievement was not significantly related to enrollment in physical education class, higher grades were associated with vigorous physical activity. Students who either performed some vigorous activity had significantly higher grades than students who performed no vigorous activity in both semesters. Moderate physical activity did not affect grades and standardized test scores were not significantly related to physical education class enrollment. Data showed that students enrolled in physical education have better academic achievement than those not enrolled in physical education due to the increased levels of physical activity gained during class time.

Sallis et al. (1999) examined the effects of a 2-year health-related school physical education program on standardized academic achievement scores. His key finding was that spending more time in physical education did not have detrimental effects on standardized academic achievement test scores in elementary school children. In fact, there was some confirmation that a 2-year health-related physical education plan had several noteworthy effects on academic achievement - achievement test scores greatly exceeded the national average at

baseline. In just about all scores in both cohorts, there were drops in achievement test percentile scores from baseline to posttest. The fact that this occurred in all conditions means the decline was not due to the physical education program.

The purpose of one research study was to examine (by means of a longitudinal study) the influence of physical education on direct measures of academic achievement in mathematics and reading from kindergarten through fifth grade, in US elementary schools (Carlson et al., 2008). Carlson points out more time in physical education may help students perform better academically, thus, physical education should be promoted. Fear of negatively affecting academic achievement does not appear to be a justifiable reason for reducing or eliminating programs in physical education. Schools should attempt to meet the national health objective of daily physical education and offer students a balanced academic agenda that includes chances for physical activity.

Author, John Ratey describes how a fitness program helped put a U.S. school district of 19,000 students, first in the world in science (Ratey, 2008b). Physical education classes teach fitness not sports, and physical education teachers in the Naperville school district in Chicago, work with student before school on a fitness program. The goal is to see if working out before school gives students a boost in reading ability and in the rest of their subjects. Reading scores went up. Ratey also argues that anatomical scientific facts lead to optimal academic learning and aerobic activity adds to brain power, potential and performance. This supporting research showed improved academic performance in the classroom, with regard to the connection between exercise and the brain.

Relationship between Physical Fitness Scores and Academic Achievement

The second approach to analyzing the mind/body relationship brings together the relationship between physical fitness test scores and academic achievement. A small number of studies have used standardized fitness scores and standardized test scores in large urban communities or examined the relationship of academic achievement and fitness among elementary and middle school children. One such study concludes that students who do well on fitness tests also do well on math and English standardized tests (Chomitz et al., 2009). The purpose of this research is to show there is a definite relationship between diverse, urban public school students' academic achievement and their physical fitness. The research intended to determine the relationship between physical fitness as measured in 5 area, and standardized achievement as measured on the Massachusetts Comprehensive Assessment System (MCAS) Math and English components in fourth-, sixth-, seventh-, and eighth-grade public school students. The odds of passing both standardized math and English tests increased as the number of fitness tests passed increased, even when controlling for gender, race/ethnicity, and socio-economic status. Findings add to a growing body of evidence indicating a major relationship between students' academic achievement and physical fitness.

Grissom (2005) agrees as overall Physical Fitness Test (PFT) scores increase, mean achievement scores also increase in a statistically noteworthy way. Grissom used scores on a physical fitness test and compared them to reading and mathematics scores on the Stanford Achievement Test (a standardized norm-referenced achievement test). As the overall PFT score improved the mean reading and mathematics NCE (Normal Curve Equivalent) scores also

improved. When the overall PFT score was compared to mean reading and mathematics scores, there was a uniform positive relationship between physical fitness and academic achievement.

A detailed study of the relationship between the elements of physical fitness (e.g., aerobic capacity, muscle fitness, and body composition) and academic achievement (e.g., mathematics and reading) was also conducted within schools that were selected based on numerous socio-cultural variables (Castelli, Hillman, Buck & Erwin, 2007). Findings from this study indicate that “physical health is related to academic performance in addition to national health goals and, as such, warrant consideration in educational and public policy making” (p. 248). For that reason, opportunities for students to be physically active and become physically fit ought to be provided by the school, particularly at the elementary level. Findings from this study also call for comprehensive investigation of “physical education programs from the micro (i.e., lesson content, frequency, quality) and macro (i.e., national, state, district policies) levels, thus enhancing the benefits associated with aerobic fitness and healthy BMI, in relation to academic achievement” (p. 248). This study confirms that physical fitness is “generally” associated with academic performance in elementary school children. Aerobic fitness and BMI were related to achievement in reading and math, while strength and flexibility fitness were unrelated to academic achievement, reading, and math.

Suggesting aspects of physical fitness may be globally related to academic performance in preadolescents, is a notion shared by the American Heart Association (2010). Physical fitness is associated with academic performance in young people, according to a report presented at the American Heart Association’s 2010 Conference on Nutrition, Physical Activity and Metabolism. This literature addresses the association between children’s physical fitness and academic

performance, examining the body mass index percentiles, fitness levels and standardized academic test scores. Findings include:

- Students who had the best average scores in standardized tests in reading, math, science and social studies were fit at the start and end of the study
- Academically, the next best group in all four subjects, was made up of children who were not fit in fifth grade but had become fit by seventh grade
- Third in academic performance were the children who had lost their fitness levels between fifth and seventh grades
- Students who were not physically fit in either the fifth or seventh grades had the lowest academic performance

The study advocates that centering more on physical fitness and physical education in school would result in children who are healthier, happier and smarter. The message from this study is we desire for our kids to be fit as long as possible and ultimately have this reflect in their academic performance. Children who are habitually active have an increased chance of a healthy adulthood. The American Heart Association recommends that children and adolescents should partake in 60 minutes or more of physical activity daily - physical activities that are appropriate for their age and enjoyable.

Relationship between Physical Activity outside the Classroom Curriculum and Academic Achievement

The first of five pieces of literature regarding the relationship between physical activity outside classroom curriculum and academic achievement makes reference to the Trois Rivieres experiment. This experiment was carried out jointly with Dr. Hugues Lavallee in the Province of Quebec in which 546 primary school students from an urban and a rural school participated in a curriculum that was modified in grades 1 through 6 to incorporate 1 hour per day of additional physical activity (Shephard, 1996). The author examines whether involvement in a regular physical activity program improves or deteriorates academic performance and whether any changes in academic performance are related to changes of cognitive or psychomotor function. Control students were exposed to an identical domestic and overall academic environment but spent about 13-14% more school time on academic instruction. Academic outcomes were reported by each homeroom teacher at the end of each school year, and province-wide exams were completed at the end of grade 6. Students in the control classes, initially, had better grades than the experimental students, but in grades 2 through 6, the experimental students outperformed the controls, significantly so in grades 2, 3, 5, and 6...The girls outperformed the boys in all grades. This research may suggest that academic performance per unit of class time is improved rather than worsened if curricular time is assigned to required programs of "habitual physical activity." Province-wide tests support this viewpoint for math but, in the Trois Rivieres study, do not show benefit in language or in "overall intelligence." This research also suggests regular physical activity might influence cognitive development by increasing blood flow to the brain.

The University of Illinois at Urbana-Champaign (2009) agrees with these claims by Shephard. The goal of the University of Illinois study was to see if a single acute bout of moderate exercise – walking – was beneficial for cognitive function in a period of time afterward. The study maintains physical activity may increase students' cognitive control – or ability to pay attention – and also result in better performance on academic achievement tests. In an effort to see how performance on such tests relates to actual classroom learning, researchers next administered an academic achievement test. The test measured performance in three areas: reading, spelling and math. Following the acute bout of walking, children performed better on specific tasks, and had a higher rate of accuracy, especially when the task was more difficult. Along with that behavioral effect, results showed that there were changes in the child's event-related brain potentials (ERPs). Following acute bouts of walking, children were better able to bring up concentration resources, and this effect is greater in the more difficult conditions of the test, suggesting that when the environment is noisier – visual noise in this case – kids are better able to tune out that noise and selectively attend to the correct stimulus and act upon it. The effect was largest in reading comprehension – in fact, if you go by the guidelines set forth by the Wide Range Achievement Test, the increase in reading comprehension following exercise equated to approximately a full grade level.

Stevens, To, Stevenson, and Lochbaum (2008) are credited with finding the independent involvements of physical activity not associated with controlled physical education and school based physical education participation to academic achievement in students. The disconnection

of the physical activity from physical education accounts for the possible limitation in assuming that participation in a physical education class equates to moderate to vigorous physical activity. Physical activity was measured using three variables that were collected during the individuals' third grade school year (parents rate their child's incidence of aerobic activity on a consistent basis compared to other children the same age). Parents were also asked, in a typical week, on how many days does your child get exercise that causes rapid breathing, perspiration, and rapid heartbeat for 20 continuous minutes or more? Finally, parents were asked if their child was active in regular exercise like sports teams or leagues. Physical Education was assessed using one variable collected at three times; spring of kindergarten, spring of first grade, and spring of third grade. The results of the investigation clearly indicate that parent reported physical activity engagement of their child was more positively influential on math and reading achievement than was physical education participation (Physical activity was comprised of parents' measure of their child's involvement in aerobic activity, exercise for 20 minutes in duration minimum, and participation in sports other than physical education class). The conclusion is that physical education (within the school day) does not improve or detract from academic achievement - specifically math and reading achievement. The results also support the more recent results of Coe and colleagues (2006) and Grissom (2005). Coe et al., found while physical education was not related to academic achievement, physical activity engagement meeting some or all of the guidelines for vigorous physical activity was significantly related to higher grades over two semesters. It appears from Stevens' data that physical education (as it is currently taught) in many schools, does not improve or impair academic achievement in "pre-pubescent" school aged children. It seems that the key exercise factor is that of intensity.

Physical activity has been shown to have a negative relationship with BMI, a positive affect on self-esteem, and a minor negative relationship with academic performance (Tremblay, Inman, & Willms, 2000). The purpose of this study was to examine the relationship between participation in physical activity, academic achievement, self-esteem, and body-mass-index in a significant sample of sixth grade students in New Brunswick. Questions were asked about academic and social climate of their home and classroom, family background, participation in physical activities, and self-esteem. Questionnaire responses were merged with students' test scores in reading, math, science, and writing (based on standardized tests administered by the department of education). Physical activity was measured based on four questions in regard to students' regular participation in physical activities. When the study was concluded, it showed physical activity had a negative relationship with BMI, a positive affect on self-esteem, and a minor negative relationship with academic performance. Self-esteem improved for both male and female students who were physically active. For some children, "physical activity may be indirectly related to enhanced academic performance by improving physical health and self-esteem. In fact, any one of the measurements could affect another in a positive or negative manner.

The final bit of literature which focuses on the relationship between physical activity outside the classroom and academic achievement, describes a program aimed at offering increased opportunities for physical activity and improved nutrition at school. The Making the Grade with Diet and Exercise (MGDE) program was implemented in the year 2000 at Springfield Local Elementary School in New Middletown, OH (Sibley, Ward, Yazvac, Zullig, &

Potteiger, 2008). The program has “three core components: 1) environmental change to increase access to physical activity every morning, 2) access to a free breakfast program to facilitate sound nutritional intake for all students, and 3) a reversal of the order of lunch and recess, such that recess occurs before lunch” (p. 40). The first component of the program dealt with adjusting the school schedule to concentrate on a 10-20 minute physical activity period with teachers and students at the start of each school day. The teacher-led classroom activities offered moderate to high levels of activity for students and teachers, were straightforward and manageable (minimal amount of equipment needed). Each classroom teacher selected the activities for that day (examples included walking, running, exercise videos, calisthenics, resistance training, and gymnasium and playground games). From 2000 to 2006, school staff had seen improvements in areas of achievement test performance, attendance, student behavior, as well as other related school performance variables. “The students at Springfield have improved from passing one of the current state indicator proficiency tests (writing) prior to the intervention, to passing all three tests during the 2001-2006 school years (a school is considered to have achieved a state indicator if 75% of students at the school pass the associated proficiency/achievement test)” (p. 42). Student’s writing improved 19% the first year and maintained the improvement in each subsequent year. Reading and math scores reveal that more students are passing the subtests every year following the introduction of the program intervention. The data collected from the 6- year intervention at Springfield Local Elementary School allows for improved academic performance by increasing daily physical activity. As school administrators strive to implement changes to the learning environment, it is hoped they at least consider enacting a program similar to Making the Grade with Diet and Exercise. “A small investment of resources and innovation

has the potential to provide substantial returns by creating an improved, quality learning environment.” (p. 44). This significant body of research makes evident that physical activity and good nutrition have a positive impact on academic performance.

Relationship between Physical Activity within the Classroom and Academic Achievement

Can academic success come from five minutes of physical activity? It appears physical activity within the classroom has a definite positive impact on student learning. Maeda and Randall (2003) offers insight into this finding. The participants were a second-grade class in an elementary school (19 students - 2 of which received special education services). The class was divided into two groups based on their performance in math related to addition concepts. Students answered as many math problems as they could within one minute after a walk and/or run. The effect of the physical activity seemed to be much greater for the below grade level group compared to their grade level peers. The number of problems answered correctly by the below grade level group appeared to be more clearly affected by the physical activity. Math fluency of the students on days they did not do any physical activity was considerably different from days when they did. Anecdotal comments from the teacher were worthy of note and in favor of the physical activity. Physical activity did not negatively affect academic performance - in fact, it actually helped children do better. Overall, math fluency showed improvement, however, improvement was not limited to math fluency. Improvements in the behavior of the entire class after the physical activity were noted, and the teacher reported that they were able to get more accomplished. On the other hand, on days when there was no physical activity, she was unable to accomplish as much. More time was spent getting the class to settle down and/or

maintain their attention. The teacher also conveyed that the children enjoyed both activities “immensely”. The students often chose not to drink water after the physical activity just so they could get going on the math activity. The positive impact of the physical activity on math fluency and behavior validated this teacher’s belief that activity of a physically demanding nature is an important part of every child’s day. The students were also so eager to get started on the math activity that the time it took to return to the classroom was nominal. In the whole design of things, both activities did not take a great deal of time at all. Classroom teachers have numerous responsibilities - however, enhancing student behavior after physical activity can compensate for any time used outside of class in the amount of work that may be achieved.

The affects of a classroom-based program on physical activity and on-task behavior was studied by Mahar et al. (2006). This study assessed the effects of a classroom-based physical activity program on student`s in-school physical activity levels and on-task performance during academic lessons. At a public school in eastern North Carolina, 15 classes - three classes per grade level - kindergarten through fourth-grade, students participated in a classroom-based physical activity program called Energizers (energizers are short classroom-based physical activities). These activities offer students the opportunity to increase daily physical activity levels during the school day by allowing them to stand and move during academic instruction. The activities lasted about 10 min, incorporated grade-appropriate learning materials, required no equipment, and needed little teacher preparation. Teachers were instructed to lead one 10-min activity per day for 12 weeks. Also, teachers were trained to lead these activities, were provided copies of all activities, and were allowed to choose the activity they wanted each day.

They were informed which week their class would be evaluated for physical activity and when their class would be observed for on-task behavior. Physical activity levels were measured with pedometers to see if the daily in-school activity levels of students who participated in the Energizers activities differed from the activity levels of students who did not receive the Energizers program. The least on-task students improved statistically significant on on-task behavior by 20% after the Energizers activities. The intervention groups averaged about 782 more daily in-school steps than the control classes. The number of steps during any individual Energizers activity ranged from 160 - 1223 steps. A clear improvement in on-task behavior after the implementation of the Energizers activity was evident for every week. “A classroom-based physical activity program was effective for increasing daily in-school physical activity and improving on-task behavior during academic instruction” (p. 2086). Routine physical activity is crucial for enhancing overall health. Lifestyle behaviors embraced in childhood tend to follow into adulthood, and more active children have a tendency to be more active as adults. This helps in the prevention of diseases such as obesity, hypertension, and cardiovascular disease, as well as others.

What can we do and how can we do it?

Administrators, educators, and health care professionals in the school setting can use resources to encourage and foster a healthy level of physical activity for students. Bagby and Adams (2007) offer an evidence-based guideline to provide school-based strategies to increase the level of physical activity and reduce sedentary behavior in kindergarten through 8th-grade populations. The ultimate goal is to improve the fitness level and physical and mental health of the students and to help establish lifelong patterns of healthy behavior. Bagby and Adams

focused on three methods that have a strong research base, are easy and inexpensive to implement, and show the greatest effect on behavior changes according to current research: increasing time spent in *Moderate to vigorous physical activity* (MVPA) during physical education class, increasing time spent in MVPA during recess (free play time), and teaching skills to reduce sedentary behaviors. Although measuring physical activity in children is challenging, each of these intervention method includes a measurement tool recommended because of its adaptability to the school setting. These tools have been tested in populations of school children, have shown good reliability and validity, and may be used to measure the outcomes of the interventions.

The American Heart Association and the National Football League compiled a collection of curriculum ideas to encourage teachers to get their students more physically active in the everyday lessons with sample strategies by incorporating movement throughout the school day (*What Moves U – Get Up & Get Movin*, 2007). The program's goal is to combat the childhood obesity epidemic which is at a record high in this country. Learning objectives related to affects on the body are stated for each lesson, and lessons cover subject content in math, science, language arts, social studies, and physical education. Each begins with a brief description of the activity for that subject area. *What Moves U* and the AHA stress six main points of emphasis in its curriculum content. They claim the benefits of physical activity for students in the classroom include better academic performance, higher self-esteem, lower levels of anxiety, stress, and depression, as well as many physical health related benefits such as reduced risk of heart disease, healthy weight, and a longer life expectancy.

Kennedy (2006) goes even further and provides research which offers to accommodate students with more flexible furniture alternatives. In turn, these alternatives provide benefits both physically as well as intellectually. Activities were measured in their “old way” classroom for one week, having students sitting in chairs at their desks. Then their activity was measured in the experimental classroom for two weeks, having students stand at “standing” desks with wheels. Currently, some schools claim students have reported numerous benefits: increased awareness of their posture; a feeling of alertness, more focused; better handwriting; a larger work space; increased physical movement and opportunities to burn off extra energy; and an accommodating, more personalized approach to work habits. A similar study was conducted whereby therapy balls were used by students in place of conventional chairs. The purpose of this study was to look at the use of therapy balls for classroom seating as an intervention for children with ADHD. Two explicit research questions were focused on. First, what effect do therapy balls have on in-seat behavior? Second, what effect does sitting on these balls have on readable word production? Also, social validity was looked at to evaluate the teacher's and students' opinions with respect to the acceptability and viability of the intervention (Schilling, Washington, Billingsley, & Deitz 2003). All 3 students with ADHD reported preferring balls to chairs for comfort, writing, and productivity. In addition, 21 other students in the class reported that “they believed the therapy balls were more comfortable, improved their writing, and increased their ability to listen and finish class work” (p. 43). Of this group, 17 students claimed that they preferred balls, 2 preferred chairs, and 2 had no favorite. This study indicates that the use of therapy balls for classroom seating is one strategy that a therapist might consider when working with children with ADHD who are having trouble achieving school expectations of staying on

task and remaining seated. In addition, “this intervention strategy was found to be compatible with inclusive educational practice and interdisciplinary teaming” (p. 44).

Conclusion

Research seems to support the positive affects of moderate to vigorous physical activity in schools and its impact on cognitive development. Research also seems to point to the conclusion that there are no damaging affects on student learning when physical education classes are offered. Some researcher do, however, state additional research needs to be conducted in the relationship between the brain’s capacity to grow and increased physical activity in schools. With all the new information regarding brain research, educators must determine who is credible and who is not. More research is needed, not more application of learning theories (Tremarche et al., 2007). Tremarche and colleagues also states brain research is here to stay and school leaders and teachers have a professional responsibility to look at the research and make use of the information for application within the classroom. Even though more research is required, investments of time and resources in fitness and physical activity do not detract from academic achievement in core subjects, and may even be beneficial (Chomitz et al., 2009). Shepherd (1996) agrees and adds regular physical activity might influence cognitive development by increasing blood flow to the brain.

It appears that physical education (as it is currently taught) in many schools, does not improve or impair academic achievement in school aged children (Stevens et al., 2008). It seems the key exercise factor is that of intensity. Intense exercise could be incorporated into physical education classes that are offered more frequently. Higher grades were associated with vigorous physical activity (Coe et al., 2006). Students enrolled in physical education have better academic

achievement than those not enrolled in physical education due to the increased levels of physical activity gained during class time. Of the reviewed literature, few addressed this factor involving the intensity of the activities. Other variables to consider include the integrity of students, parents, and teachers regarding questionnaires as used by Tremblay et al. (2000), Schilling et al. (2003), Stevens et al. (2008), and Carlson et al. (2008). Still another factor to consider is the discrepancy between boys and girls. Investigators should aim to clarify how physical activity during physical education relates to measures of academic achievement and, above all, how factors associated with physical, social, and psychological growth and development may alter or “mediate” this association differently in boys and girls (Carlson et al., 2008).

Many questions regarding the relation between exercise and children’s cognitive functioning remain unanswered. It is unknown whether developments in cognition as a result of exercise are carried on following the termination of physical activity or if they decline (Tomporowski et al., 2008). Also, it remains to be seen, “if the benefits obtained are related to the type, duration, or intensity of exercise training programs” (p. 126). Putnam et al. (2004) did not address these issues of duration and intensity, and neglected to include factors involving gender differences, ethnic background, and socioeconomic status. Continued research is essential to gain a more fundamental understanding of the relationship between physical fitness and learning in children. Future research should look into which factors of physical fitness and activities gain the greatest cognitive benefits, and study the effects of physical activity and fitness through cohort groups (Castelli et al., 2007). Castelli’s and others’ research, unfortunately, was unable to make adjustments for concerns on the topic of student attitudes, which might be related to both physical fitness and academic performance. In particular, no

measure of student's motivation for either the cognitive or physical fitness tests was gathered. Consequently, student motivation remains a potential alternative explanation for these findings. Students who excel in school and enjoy their schooling experience may be more apt to put forth more effort on physical fitness and academic tests. This matter remains a viable component that should be accounted for in future studies in order to understand the relationship between fitness and academic performance.

Sallis et al. (1999) goes a step further and addresses classroom teacher training. He argues that training classroom teachers to enhance their physical education classes has encouraging effects on academic achievement and is not restricted to one subject area. Additional studies are needed to duplicate this effect and identify devices whereby improving the ability of classroom teachers to teach physical education might lead to better student academic achievement. Further basic research is needed to shed light on the effects of different types and amounts of physical activity on brain makeup and function. Inconsistencies from previous physical education studies may be due to differences in the tests administered. More studies are needed to find which academic achievement test scores are most affected by quality (moderate to vigorous) physical activity.

The need for increasing physical activity in children is clear and is now becoming a national mandate for schools. School nurses can use the information in this guideline as a resource for research-based interventions and methods for evaluation of their effectiveness. Concerns of administrators regarding loss of education instructional time and increased cost can be alleviated by providing information on low-cost strategies that do not require increased PE class time. Additional research-based information regarding studies showing academic

improvement with increased physical activity can encourage administrators and educators to make physical activity a priority. Our understanding about how the brain works has exploded within the past decade. This is an exciting time to positively impact the next generation and all those to follow by simply working with the body's natural growth and reaction to exercise. Exercise, or aerobic activity, has already been addressed as an essential ingredient in our overweight society. Promotion of fitness has already been targeted by groups like the American Diabetes Association, American Heart Association, NFL, and the United States Government to name a few. The First Lady, Michelle Obama, is talking about restructuring the nutritional environment in which children grow, from putting in sidewalks in neighborhoods to persuading students to walk to school. Why not play off of the fitness goals and utilize the body's natural physiological and neurological responses after the workout to maximize the learning potential it has prepared itself for?

John Ratey (2008b) addressed both the school and workplace settings as areas of focus for improvement in achievement, by simply getting active. What is even more promising is that each person has the power to make this happen and change their performance. Not only is the performance affected, but the state of mind is altered as well. Physical activity and movement may or may not make children smarter, but they do however, contribute to how they learn and how much can be learned. Many children in school are kinesthetic learners. Meaning, these children learn more effectively by moving and interacting with their environment rather than sitting and just receiving input visually or by listening. Although time has become a valuable resource to teachers, scheduling as little as five minutes every day of moderate to vigorous physical activity could contribute to improved academic performance and student behavior.

After the analysis of the literature in this paper, it is apparent physical education does not take away from academic performance, and physical activity almost always improves academic outcomes. It is also true researchers have been looking at physical activity as a key proponent in the way we think and feel – maybe more so now than ever. Many scholars claim exercise prepares your brain to learn. Perhaps it is as basic as the body's blood flow along with our body's chemical reactions which allow for optimal learning. Whatever the case, with more research, this mind/body connection just may revolutionize the way we structure our classrooms, curriculum, and even schedules throughout the school year.

References

- American Heart Association (2010, March 4). Students' physical fitness associated with academic achievement; organized physical activity. *ScienceDaily*. Retrieved from <http://www.sciencedaily.com>
- Bagby, K., & Adams, S. (2007, June). Evidence-based practice guideline: Increasing physical activity in schools—kindergarten through 8th grade. *Journal of School Nursing*, 23(3), 137-143.
- Carlson, S. A., Fulton J. E., Lee S. M., Maynard L. M., Brown D. R., Kohl H. W. III, Dietz W. H. (2008). Physical education and academic achievement in elementary school: data from the early childhood longitudinal study. *American Journal of Public Health*, 98, 4, 7221-727.

- Castelli, D.M., Hillman, C. H., Buck, S. M., Erwin, H. E. (2007). Physical fitness and academic achievement in third- and fifth-grade students. *Journal of Sport & Exercise Psychology*, 29, 239-252.
- Chomitz, V.R., Slining, M.M., McGowan, R.J., Mitchell, S.E., Dawson, G.F., & Hacker, K.A. (2009). Is there a relationship between physical fitness and academic achievement? Positive results from public school children in the Northeastern United States. *Journal of School Health*, 79, 30-37.
- Coe, D. P., Pivarnik, J. M., Womack, C. J., Reeves, M. J., & Malina, R. M. (2006). Effect of physical education and activity levels on academic achievement in children. *Medicine & Science in Sports & Exercise*, 38, 1515-1519.
- Grissom, J. B. (2005). Physical fitness and academic achievement. *Journal of Exercise Physiology*, 8, 11-25.
- Kennedy, M. (2006, October 1). Room for adjustment/school furniture. *American School and University Magazine*. Retrieved from http://asumag.com/Furniture/university_room_adjustment/
- Maeda, J. K., Randall, L. M. (2003). Can academic success come from five minutes of physical activity? *Brock Education*, 13, 1, 13-22.
- Mahar, M. T., Murphy S. K., Rowe D. A., Golden J., Shields A. T., and Raedeke T. D. (2006). Effects of a classroom-based program on physical activity and on-task behavior. *Medical Science Sports Exercise*, 38, 12, 2086-2094.
- Putnam, S.C., Tette, J., Wendt, M. (2004). Exercise: a prescription for at-risk students. *Journal of Physical Education, Recreation, and Dance JOPERD*, 75, 9, 25.

Ratey, J. J. (2008). Learning: grow your brain cells. *Spark: the revolutionary new science of exercise and the brain*. (pp. 35-56). New York, NY: Hachette Book Group.

Ratey, J. J. (2008). Welcome to the revolution: A case study on exercise and the brain. *Spark: the revolutionary new science of exercise and the brain*. (pp. 9-33). New York, NY: Hachette Book Group.

Sallis, J.F., McKenzie, T.L., Kolody, B., Lewis, M., Marshall, S., & Rosengard, P. (1999). Effects of health-related physical education on academic achievement: Project SPARK. *Research Quarterly for Exercise and Sport*, 70, 127-138.

Schilling, O. L., Washington, K., Billingsley, F.F., & Deitz, J. (2003). Classroom seating for children with attention deficit hyperactivity disorder: Therapy balls versus chairs. *American Journal of Occupational Therapy*, 57, 534-541.

Shephard, R. J. (1996). Habitual physical activity and academic performance. *Nutrition Reviews*, 54, S32-S36.

Shephard, R. J., Volle, M., Lavallee, H., La Barre, R., Jequier, J., and Rajie, M. (1984). Required physical activity and academic grades: A controlled study. In J. Hmarinen and I. Valimaki (Eds.), *Children and Sport* (pp.58-63). Verlag, Berlin: Springer.

Sibley, B.A., Ward, R.M., Yazvac, T.S., Zullig, K., Potteiger, J.A. (2008). Making the grade with diet and exercise. *AASA Journal of Scholarship and Practice*, 5, 2, 38-45.

Smith, P. (2010, March 8). Diet, exercise can improve thinking. *Hypertension*. Retrieved from <http://health.msn.com>

Stevens, T.A., To, Y., Stevenson, S.J., & Lochbaum, M.R. (2008). The importance of physical activity and physical education in the prediction of academic achievement. (Report). *Journal of Sport Behavior*. Retrieved from <http://www.highbeam.com/doc/1G1-188739131.html>

Stolberg, S.G. (2010, February 9). Fitness & nutrition childhood obesity battle is taken up by first lady. *New York Times*. Retrieved from <http://www.nytimes.com>

Tompsonski, P.D., Davis, C.L., Miller, P.H., Naglieri, J.A. (June, 2008). Exercise and children's intelligence, cognition, and academic achievement. *Educational Psychology Review*, 20, 2, 111-131.

Tremarche, P.V., Robinson, E.M., & Graham, L.B. (2007). Physical education and its effect on elementary testing results. *Physical Educator*, 64, 58-64.

Tremblay, M.S., Inman, W., Willms, J.D. (2000). The relationship between physical activity, self-esteem, and academic achievement in 12-year-old children. *Pediatric Exercise Science*, 12, 312-323.

University of Illinois at Urbana-Champaign (2009, April 1). Physical activity may strengthen children's ability to pay attention. *Science Daily*. Retrieved from <http://www.sciencedaily.com>

Zhao, Y. (2009). Why china isn't a threat yet. *Catching up or leading the way – American education in the age of globalization*. (pp. 88-89). Alexandria, VA.: ASCD (Association for Supervision and Curriculum Development)

Curriculum Packet

What Moves U – Get Up & Get Movin (2007). American Heart Association and National Football

League. Retrieved from <http://www.WHATMOVESU.com/teacher>