THINKING CAPS AND RUNNING LAPS: EXPLORING THE IMPORTANCE OF PHYSICAL ACTIVITY AND COGNITIVE DEVELOPMENT

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THINKING CAPS AND RUNNING LAPS: EXPLORING THE IMPORTANCE OF PHYSICAL ACTIVITY AND COGNITIVE DEVELOPMENT

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ACKNOWLEDGEMENTS

My love for education comes from my earliest teacher, my mother. From her I learned right from wrong, how things worked, and the importance of having the freedom to be a kid while you still can. Her father was a fifth grade teacher, and was a "kid" his entire life. He inspired my mother to become a teacher, and that legacy continues as I prepare to go into my classroom. My daughter is also beginning her journey down a similar path. Without the examples of teachers in my family, my dream would not have been possible.

Those family members have made great sacrifices to help me get to this point in my education. My parents have helped to support me emotionally (as well as financially) in the pursuit of my goals. They are my greatest cheerleaders, offering encouragement and advice every step of the way. The greatest sacrifice, however, has been born by my daughter as she has grown into an independent young woman while I have been absent due to work and school. I cannot thank my family enough for being both my rock and my soft place to land during these sleep deprived years.

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Damon Adam, who directed me to John Medina's brain research and put me on this research quest.

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LIST OF ABBREVIATIONS

Abbreviation **Description**

ADD – Attention Deficit Disorder

ADHD – Attention Deficit Hyperactivity Disorder

BDNF - Brain Derived Neurotrophic Factor

MRI – Magnetic Resonance Imaging

NCLB – No Child Left Behind Act of 2001

PE – Physical Education

PET scan – Positron-Emission tomography

RttT – Race to the Top

SPECT scan - Single-Photon Emission-Computed Tomography

ABSTRACT

This research looks at peer-reviewed articles related to the impact physical activity has on cognitive development. I attended a conference where I heard from experts about the positive impact physical activity has on the brain. Many elementary and secondary schools are cutting physical education courses in exchange for bolstered core curriculum classes as a result of budgetary constraints or pressure to improve academic standings. By synthesizing the data from multiple studies which analyzed the affect of physical activity on cognition, my goal was to find commonalities in the duration and type of exercises researchers used. The hope was to identify the most effective exercises which could then be adapted for classrooms. I found that most articles did not specify the type of physical activity performed, and there was no consensus as to the optimal activity. Benefits start with five minutes of physical activity, with optimal cognitive benefits after 30 minutes of cardiovascular activity. I then surveyed two dozen teachers for their opinions about physical activity, cognitive development, and the feasibility of implementing physical activity in their classrooms. Most of those surveyed were aware of the relationship, but cited implementation difficulties due to constraints of time and physical classroom size. Twenty of those surveyed stated willingness to implement a brief non-disruptive activity. My conclusion is that students can gain cognitive benefits from brief physical activities such as stretching or breathing exercises while in the classroom. A program should be developed giving educators training for use in the classroom.

CHAPTER I

INTRODUCTION

Teachers, We Have a Problem

Imagine learning in a classroom. You are sitting in a hard chair behind a hard desk while the teacher is lecturing the students from the front of the room. The teacher points at the board, instructs you to look at a passage or an example in the textbook, and drones on and on. This is the same routine you experience every day, and you are losing the fight against boredom and possibly drowsiness. Are you bored just reading this scenario?

Would it make a difference if the lesson involved taking a moment to stand up and stretch your muscles a little? What if the teacher asked you to move around so you could pull some fresh oxygen into your lungs and get your blood pumping? Would this grab your attention and perhaps make you more excited to learn? Would this peak your interest and help you feel more energized and engaged in the lesson?

Not only does the second scenario *sound* more enticing, but science has proven that it is a better way to learn. A mounting body of research performed over the past few decades shows that an increase in physical activity can be directly linked to improved cognitive development. Although the research related to the cognitive benefits associated with physical activity is sound, educators have found it difficult to implement physical activity into their already stressed schedules. Physical activity is rarely implemented within modern day American classrooms.

So why the disconnect? Today's teachers are saddled with a growing list of responsibilities in a world full of testing requirements and quantitative performance expectations. This is stressed further with increased mandates on high-stakes testing and the demands of directives such as No Child Left Behind. Electives are crashing to the cutting room floor as school districts try to meet the ever-increasing standards by replacing them with core curriculum-centered courses.

Under pressure to meet testing mandates, the focus has been on increasing remedial and tutoring programs in order to supplement areas where students seem to be falling behind academically. In order to add time for academics, recess and physical education (P.E.) have been cut. Despite a lack of evidence showing this to be an effective strategy, the trend has been to bolster academics at the cost of P.E. On the contrary, increased physical activity has been proven to result in either neutral or positive academic performance (Basch, 2011).

Even though the correlation between exercise and cognitive benefits are well documented, these cuts are still being made. As a future educator, I wanted to know why, and what I could do in my classroom to help counter this trend. This led me to wonder if there are specific types of physical movements that are most beneficial, and how to apply that knowledge across a variety of content areas. By looking at past research, it was my hope to identify which specific types of physical activities corresponded with positive measurable improvements in cognitive development and overall student academic performance. Furthermore, if I did come across an optimal and usable form of physical activity, would other teachers be willing to implement my findings in their classrooms?

The Human Brain: The Next Frontier

Much like the vast expanses of outer space, most of the inner-workings of the human brain are still a complex mystery to scientists. Researchers are putting a lot of energy and focus of late into investigating how the human brain works and are making great strides. Advances in technology have made it possible for experts to monitor and track a wide variety of brain activities. Scientists are able to monitor and observe brain functions occurring during all forms of human action, including sleeping, exercising, and learning. Experts are then able to make comparisons based on different forms of stimuli to see how the human brain reacts.

Today's technology makes it possible to actually watch people think. Utilizing technological advances such as single-photon emission-computed tomography (SPECT scan) and positron-emission tomography (PET scan), scientists can graphically illustrate brain activity as it occurs (Craig, 2003). Researchers have been able to document which regions of the brain are interdependent, how the different regions are related, and what type of actions or stimuli trigger the firing of synapses.

What researchers have found is that the brain is continually changing and remains plastic over the course of our lives. Over the past two decades, researchers have used magnetic resonance imaging (MRI) to show how regions of the brain are activated by certain stimuli (Stevens-Smith, 2006). During our early years of development there is predominant structural growth and changes in the human brain. Specific regions of the brain generally develop along a predictable timetable until we are into our early 20's. Even into old age, with the right stimulation and use, the brain can become increasingly

more efficient and strengthened. The lack of use, however, reflects a decline in the number of effective pathways and connections between neurons (Craig, 2003).

Science has found a way to help counteract these declines. Data collected over the past several years have shown a consistent relationship between increased physical activity and improved cognitive development. The increased flow of blood and the toxin-sweeping work of oxygen are possible sources of this enhancement (Medina, 2009). This increased blood flow, coupled with an increased production of nerve growth factors (Brain Derived Neurotrophic Factor, or BDNF) stimulates the formation of synapses, spines, and neurons in the brain (Hollmann, Strueder, & Tagarakis, 2005). Numerous reports show that physical activity results in improvements in memory, comprehension, and even behavior. The problem? We need to discover a way to execute this in today's youth in our classrooms.

The Demise of Physical Education Programs in Schools

With government budgets across the nation threatening to go bust during the recent economic downturn, school districts have felt the economic pinch. The financial woes faced by education sectors also collided with No Child Left Behind Act of 2001 (NCLB), requiring improvements in reading and mathematics to be regulated at the state level. Newer legislation in 2009 added even more pressure in the form of Race to the Top (RttT). States are under pressure to create a national curriculum, while RttT offers a performance-based reward system which provides financial relief in the form of federal grants to schools which meet expectations (Popham, 2013). Efforts to make the necessary financial cutbacks while meeting the increased federal mandates created a push to slash programs that were perceived as "unnecessary." According to a May 2013 news release by the Institute of Medicine, programs such as physical education, recess, art and

music were cut in favor of additional instructional time for reading and mathematics, as reported by 44 percent of school administrators (Cook, 2013).

Just as schools across the nation began replacing time in the gym or on the playground with additional instructional time behind the desk, additional legislation passed in 2004 called on schools to develop wellness policies (Public Law 108-265). This mandate requested that states implement measures related to child nutrition programs, including school food services, nutrition education, and encouraging regular physical activity. With the seemingly conflicting goals of the two mandates, school districts were left to weigh the pros and cons of the needs of their specific student bodies.

These cuts hurt our students on several levels. A 2003 article in *Pediatric Exercise Science* reviewed the results of multiple studies which looked at the correlation between physical activity and cognition. The results of the study concluded not only that that physical activity in school does not compromise academic achievement, but that the health benefits are the least of the advantages gained from increased activity (Sibley, 2003).

Despite all the evidence pointing to the benefits, researchers have yet to assimilate this data into a concrete, applicable form which can be utilized in the classroom. And our students are the ones losing out. John Ratey's 2008 book, *Spark*, describes how only 6% of American high schools have daily physical education (PE) classes available for students (Ratey, 2008). The result has been an increase in obesity rates and a decrease in standardized test scores across the nation.

But a change is possible. If the addition of motion is in fact beneficial to one's brain and improves cognitive development, and simple and tested practices can be

applied in a typical classroom setting, then teachers and administrators could implement mandated physical activity in schools for the specific purpose of increasing cognitive development. The addition of structured exercise in the classroom should not only improve cognitive development and student behavior, but would also outweigh any perceived costs due to lost academic instructional time in our schools. In addition, post-secondary teacher education programs could train prospective educators how to integrate and employ physical activities in the classroom so that they will begin their careers with the benefits of physical activity in mind.

CHAPTER II

METHODS

The Purpose of the Search

The purpose of this thesis was to review existing literature on the subject of physical activity as it relates to cognitive development in order to ascertain if there are indeed cognitive benefits as a result of physical activity, and how that knowledge might be applied in the classroom. By using a variety of methods such as reviewing peer-reviewed literature pertaining to both physical activity and cognitive development, attending a national Learning and the Brain Conference, and speaking to experts in the field of neurosciences, my goal was to uncover the most effective application of physical activity to be used in a classroom setting.

I gathered a variety of perspectives in order to learn if an exercise program utilized in the classroom with the intention of improving academic performance would be feasible. Although the cognitive benefits of movement have been proven, a greater force is needed to create mandates and ultimately the implementation of future system-wide programs. A comparison of effective methodologies should yield a range of possible exercise which could be put into practice in schools.

Review of Literature

The literature review began as a simple search for peer-reviewed articles using key words “physical activity” and “cognitive development.” This yielded a very high number of results, so the search field was significantly narrowed down by using additional search terms brain, research, human, education, test, exercise, child, and

student. The search was further narrowed down by language and geographical category filters.

I began my review by reading dozens of research articles which focused on brain functions and development, physical activity, and education. As I read them, I identified patterns indicating that cognitive development is enhanced with physical activity. Below I highlight some of the most informative articles along with their key findings and provide a chart with detailed information about each study (See Table 1). In order to further synthesize the data, I narrowed my query down to three basic questions. Question 1: Does research confirm that cognitive development can be improved with exercise? Question 2: Is there a common physical activity used in the studies? Question 3: Are there any specific physical activities recommended by the studies?

Some of this research dates back into the 1950's when the concept of physical education as part of the school curriculum was new and needed to be justified (Shephard, Trudeau, 2008). Each study has taken a different approach to the research, with a vast range of methodologies having been used. The studies tested a wide range of participants. Some have tested pre-school aged children, (2-5 years), measuring brain activity during the known peak of growth and development of the human brain. Several studies focused on groupings of elementary-aged students (5 to 11 years old), with applications of both short and long doses of exercises. Some of the exercises are generalized such as "walking," while others are more structured with specifically designed aerobic activities meant to stimulate both the left and right hemispheres of the brain at optimal physical performance levels.

There are also many studies aimed at older students. With the changing hormonal levels of pre-pubescent middle school aged children (11-14 years), the brain takes on new interests and learns on a different level. One of the key characteristics of cognitive development during this stage is the intrinsic importance of social interaction as the influence of peers and groupings has a great impact on how the adolescents grow and adapt. This has resulted in some studies looking at how cognition is uniquely affected by belonging in groups such as athletic teams. There may also be a correlation between cognitive development and competitive sports activities specifically related to the group dynamic and a sense of teamwork (Basch, 2011).

Other research documents what happens to the brain as it ages. With the great influx of aging "baby boomers," a drive to better understand the ailments and afflictions of the elderly have also resulted in a large number of research queries. While the inner workings of the aged brain are different than those of a young and more malleable child's brain, there are still some similarities. The brain is still capable of learning, growing, and improving with the right stimuli (Erickson, Miller, Weinstien, Akl, & Banducci, 2012).

Whether specific to pre-school aged toddlers, adolescents, young adults, or the elderly, there are a number of avenues pertaining to brain research. Through comparisons of these existing studies I identified common links, showing what methodologies have worked and are proven to yield the best results for students. By identifying the commonalities between findings, I formulate feasible suggestions for implementation in our schools.

The first article I highlight was a study performed on a group of 7th grade students in Germany. The study compared a control group of students who performed 5 minute

movement breaks (jogging in place, walking, shadow boxing) against a test group of students who participated in 30 minutes of vigorous PE class (running, jumping, stepping over benches at a fast pace). Participants of the 30 minutes of PE displayed an increased ability to focus following the physical activity. Researchers attributed these results to increases in serotonin levels. They also discovered that the serotonin levels peaked for only about 10 minutes following the exercise, and then gradually decreased during the following hour. The authors of the study recommended an increase in PE programs, and suggested that the benefits would be best utilized if PE took place right before important academic subjects (Kubesch, 2009).

The second article I reviewed stood out due to its unique approach to activating the brain. In *Balancing with the Brain in Mind* the author explains the importance of creating connections in the brain which are essential to childhood development. When children perform acts of spinning, balancing, or even tumbling, connections are being made across the brain from top to bottom, left to right, and front to back, depending on the physical movement. Both sides of the brain are activated when movement is utilized across the body's midline (left/right division of the body). Different types of movement create neural pathways which are critical to growth, especially during the early years of childhood. Once the pathway is created, the synapses (connections between neurons) can be strengthened with repetition and experience. Teachers can activate these paths by introducing balance-related activities in the classroom (Stevens-Smith, 2006).

In Dr. Charles Basch's 2011 research article, *Physical Activity and the Achievement Gap Among Urban Minority Youth*, he focused how physical inactivity is having a disproportionately negative impact on urban minority youth. He pointed out that

physical activity not only has cognitive and health benefits, but that being involved in team sports helps build a sense of connectedness and pride which can in turn improve student behavior, focus and productivity. There is also the opportunity for students to learn self-regulation and social-emotional skills such as teamwork. The recommendations in the article were to increase physical activity through structured PE courses, extra-curricular activities, and through the promotion of walking or biking to school (Basch, 2011).

The final two articles I analyzed turned out to be from the same set authors. One article was significant because the authors reviewed and compared multiple research studies. In a 2008 article, *Physical education, school physical activity, sports and academic performance*, researchers Trudeau and Shephard reviewed seven quasi-experimental and nine cross-sectional studies. There were several types of physical activities utilized across multiple time frames and a variety of academic tests used to measure the changes in cognition of the participants, including math, reading, and even behavioral tests. A synthesis of the studies indicates that there is a positive connection between physical activity and stimulation of the hippocampus, the area of the brain which mediates memory, as well as increased synaptic activity and neuron formation. The authors suggest that there should be a greater emphasis on sports and physical activity in schools, and that PE courses should be increased rather than cut (Trudeau, Shephard, 2008).

The second article by Trudeau and Shephard (2013) was significant because it reported on data collected for over 40 years. The authors of *Quality Daily Physical Education for the Primary School Student: A Personal Account of the Trois-Rivieres*

Regional Project not only reviewed research performed in the 1970's, they also followed up with the participants at intervals over the years to document how their attitudes toward physical activity changed over time. The original participants performed a variety of physical tasks including running, jumping, team sports, skating and gymnastics for 40 minutes a week in their home room. The findings of the study suggest that the overall physical health of the participants was improved, and time taken away from academics in exchange for curricular activities resulted in a slight overall improvement in school performance. The authors stated that educating students about physical activity was a key component to the continued success of the participants (Shephard, Trudeau, 2013).

As a result of my literature review, I found some commonalities throughout the different studies. While I was not able to find answers to all of my questions, I feel satisfied with the synthesis of the data I analyzed.

- *Focus Question 1: Does research confirm that cognitive development can be improved with exercise?* Every article I read acknowledged that physical activity has a positive effect on cognitive development.
- *Focus Question 2: Is there a common physical activity used in the studies?* Due to the combination of insufficient documentation and the vast array of physical activities used in the studies, a common physical activity could not be identified among the research studies.
- *Focus Question 3: Are there any specific physical activities recommended by the studies?* While some of the articles did have examples which could be used in the classroom, none of the studies gave recommendations as to the specific physical activities which students should perform.

While researchers differ on their approaches, methods, and techniques, two conclusions can be made from their data. First and foremost, across the board the researchers agree that physical activity improves cognitive development. Students would benefit from increased physical in the form of enhanced cognition as well as mental, emotional and physical health. Secondly, even though the amount of time spent performing physical activities directly correlates to the cognitive development, participants can still reap benefits from even a few minutes of physical activity. By incorporating physical activity into the classroom, teachers and students should come out ahead. With that in mind, I decided to survey educators in the field to understand how these findings play out in the real world.

Educator Survey

The purpose of the educator survey (See Appendix A) was to ask the opinions of the men and women in the teaching field about the possibility of implementing physical education-based movement activities in their school or classroom. By surveying educators, I hoped to determine if they were aware of the correlation between physical exercise and cognitive development, their feelings about classroom management, and the manageability of actually implementing any type of physical activity program in the classroom.

The survey was sent to professionals in the education field, including teachers, administrators, and other faculty members. Questions on the survey included general knowledge about the relationship between physical activity and cognition, teacher preference for activity levels in the classroom, and their beliefs about the best learning environment for students. The survey also asked teachers to rate their own learning

experiences from their youth. Participants answered on a five-point scale ranging from strongly agree to strongly disagree.

I received results from 26 educators; 24 teachers and two administrators. Most of the respondents were strongly aware of the correlation between physical activity and cognitive development. Twenty of the teachers indicated a strong or neutral willingness to implement a brief non-disruptive physical activity in their classroom. Most of the concerns voiced about having students engaged in physical activities in the classroom were based on time and space constraints.

Some of the participants added written comments in addition to the survey questions. One teacher responded that starting class with physical activities resulted in the students being even more restless and fidgety than usual. Another statement said that the teacher would be willing to look at a program, but would not enact it unless it was mandated by the administration. The two administrators who responded were not only aware of the correlation, but both commented that they expect to see a top-down movement toward more physical activity in schools.

Even though there is some slight resistance to adding physical activity in the classroom, it seems that most educators are at least aware of the connection, and are willing to take on the challenge if a program is presented to them. While students can benefit from the addition of physical activity, teachers appear to be hesitant about proactively implementing a program on their own, and are unsure as to how to begin. By educating teachers about the positive impact of physical activity on cognitive development, they may become more receptive to the idea and appreciate the overall benefits which can result from adding physical activity in the classroom.

Expert Interviews

I attended the Learning and the Brain Conference in San Francisco, California from February 13- 15, 2014. Several of the leading experts on brain research spoke on issues related to cognitive development, learning, and how educators can apply recent research discoveries about how the brain works in the classroom. Many of the presenters spoke about the link between physical activity and cognitive development during their conference addresses. I was also able to speak to several experts directly.

I assimilated several professional opinions to answer the following questions: How important is physical activity to cognitive development? What does your research show in terms of the benefits of physical activity on increased cognitive development? Should educators incorporate physical activity in the classroom setting? (See Table 3)

Several experts were able to give me great insight into the inner workings of the brain. Their research was consistent with my findings through the literature review. Each expert agreed that being physically active is a key component to improving cognition, and that the burden of implementation falls on the shoulder of teachers. I was also given several science-inspired techniques for use in the classroom.

CHAPTER III

CONCLUSIONS

Recommendations

There are definite benefits to be gained from adding physical activity to the school day, including in the classroom. Even brief physical activities such as stretching or breathing exercises can give students an advantage. A program should be developed which will give educators training and tools so they can customize the activities to fit their specific needs.

The changes need to start at the top with federal and state assistance, as well as local support through our school districts. Although the practicality of implementation is limited, there are several advantages to increasing the amount of mandated physical activity within our schools. While there are only so many hours in the day available to educators, and there is only so much money available for administrators, there are simple, low-cost avenues available for nearly all able-bodied students. The key is for educators to identify the program or activity which fits the specific parameters of their classroom, subject area and students. I compiled a listing of several activities which teachers can modify for use in the classroom (see Table 3).

One possible direction for educators can be found in a book by Julian Reed titled *Active Education* (2009). Reed explains what current brain research recommends about movement and its affect on cognitive development. The book also has a plethora of ideas and specific suggestions for integrative activities. These suggestions are broken down by

subject with ideas specific to English/language arts, math, science and social studies. There are also suggestions for students with ADD and ADHD (Reed, 2009).

Recommendations for both in school and out of school activities can garner results. One suggestion is that schools should promote physical activities outside of school time by recommending that students bike or walk to and from school when possible (Basch, 2011). Another plan suggests the use of an in-class program called *Energizers* for grades K-5 which provides short periods of physical activity. This program requires training for teachers, but incorporates classroom-based physical activities which are integrated with academic content and have been shown to improve both behavior as well as academic performance (Mahar, 2011).

While increasing movement whenever possible is important, there are other, equally important aspects which are easier for teachers to apply. For example, Debbie Craig pointed out the significance of emotions and the brain, recommending that teachers be cognizant of their students' schema while striving to make personal connections in a stress-reduced environment. The ability of children to relate to the content, refine their patterning, and develop problem solving techniques is critical to brain development (Craig, 2003).

Another innovative program is to engage students in guided breathing and meditative activities. Dr. Ghahremani gave a presentation at the Learning and the Brain conference in San Francisco highlighting the positive effects on participants in a program titled "YES!" short for the Youth Empowerment Seminar. This program immerses urban area high school students in guided breathing and physical motions. What they have found is that these breathing techniques specifically affect the amygdala, which signals

threat, and the pre-frontal cortex, which is allowed to kick back in and regulate the emotions and promote self-control. It also helps rid the body of toxins, and triggers the release of the neurotransmitter serotonin which regulates mood and memory, and the neurotransmitter dopamine which impacts critical thinking and reward-motivated behavior (D. Ghahremani, personal communication, February 14, 2014). Not only did the students in the study show improved impulse control, but they also saw significant improvements in their academic testing scores (Ghahremani, 2013). Implementing simple breathing techniques, even on the classroom level could be a manageable feat for most teachers.

Ultimately, the amount of activity is what matters, not the specific type of activity (Godman, 2013). The important thing to remember is that any type of physical activity has intrinsic benefits, whether it is stretching, deep breathing, hopping in place, or running laps. While the longer the duration the better, even a few minutes of students waving their arms around in the air or playing a quick game of human checkers to get the blood flowing to the brain is better than sitting comatose and cognitively unresponsive. The key is to identify little ways to insert action into daily teaching opportunities to give our students small jump starts along the way.

Obstacles

Educators may cite a variety of reasons for hesitating to implement physical activities. For some it could be simply that they do not want to exclude any students who are limited in their abilities to fully participate. This may be due to physical, psychological, or emotional traits which could limit or restrict a student's performance. Others hesitate because of physical space. Implementing any type of physical routine in

the confines of a classroom is difficult at best. Many classrooms simply do not have enough physical space for students to move around in. With class sizes growing, and students often carrying large backpacks full of school supplies, lunches, and personal belonging, floor space is also at a minimum. For a classroom full of students to be physically active while surrounded by hard desks and chairs, safety concerns would automatically trump jumping jacks.

The biggest obstacle educators face, however, seems to be that of changing the mindset of the educational community. Educator preparation courses need to include training and strategies so tomorrow's educators are equipped with physical activity programs. The training should also extend to Physical Education teachers who can be trained to integrate skilled movement curriculum designed to further enhance cognitive development (Landers, Kretchmar, 2008).

The results of decades of studies prove the direct correlation between physical activity and improved cognition. Students learn better when their bodies are active. This science needs to be implemented all the way up the chain of command. Teachers need to be empowered to get their students moving under the supervision of administrators, at the request of school districts. Governments need to mandate changes in how we approach education so training programs can be created and implemented so today's teachers, as well as tomorrow's up and coming educators will be well-equipped to give our children every advantage for a healthy and intelligent education.

APPENDIX SECTION

APPENDIX A

SURVEY QUESTIONS:

Please answer the following questions with one of the following ratings:

Strongly Agree, Agree, Neither agree or disagree, Disagree, Strongly Disagree

Definitions:

Physical exercise: sustained aerobic bodily movement

Movement: physical actions of the body or person

Brain break: a brief mental break taken during instruction in order to optimize learning

Physical exercise helps improve cognitive development.

I would be willing to implement structured movement into my daily teaching routine.

I prefer a quiet, orderly learning environment.

Exercise or movement causes students to become active and disruptive.

Exercise or movement should be limited to physical education class or recess.

I try to incorporate some movement into my lesson plans.

My students don't follow my classroom rules if I allow them to be out of their seats.

I am familiar with research showing a correlation between cognitive development and improved learning.

The lessons I most clearly remember when I was in grade school were fun and active.

The lessons I most fondly remember when I was in grade school were in a controlled environment.

Brain breaks are essential to learning.

Brain breaks are a distraction to cognitive development.

Students learn best by being active and “doing” rather than by sitting and listening.

I could fit 1 minute of structured physical exercise into my daily lesson plan.

A daily exercise mandate would be a good thing for my students.

Students become hyper when they cannot expel their energy.

Students need a structured way to focus their energy.

I would like a guided source of instruction to help my students increase their cognitive development before starting class.

Briefly answer the following questions:

Please list your occupation.

Please list the grade level(s) you work with.

Please list the subject area you teach.

Table 1. Review of Literature					
Focus Question 1: Does research confirm that cognitive development can be improved with exercise? Focus Question 2: Is there a common physical activity used in the studies? Focus Question 3: Are there any specific physical activities recommended by the studies?					
Article reviewed	Methodology	Context/ Participants	Study Findings	Key Conclusion	Synthesis: Answer to Focus Question
A 30-Minute Physical Education Program Improves Students' Executive Attention (Kubesch, 2009)	5 min movement break (jogging in place, shadow boxing, etc) or 30 min PE program (running over benches, jumping, invigoration exercises, etc)	81 7th graders in Germany	On-task attn improved by aerobic endurance exercise-based PE program, but not by the break. Duration of program is key for improving student **executive attention.**	Possible increased synthesis of serotonin in 30 min PE may lead to increased serotonergic tone – suggests a serotonergic modulation in the prefrontal cortex occurs simultaneously with decreased **impulsivity**	1. Performance enhancement in flanker test has maximum increase within first 10 minutes after exercise, with continual decomposition of serotonin during the following hour. 2. Activities varied greatly: running, jumping, etc. 3. Recommendation: PE should be increased in schools and scheduled prior to important subjects, and that any type of cardiovascular is beneficial.
Balancing with the Brain in Mind (Stevens-Smith, 2006)	General balance and brain information	None specified	Balance activities stimulate the **vestibular system,** enhancing the **three brain dimensions** (left to right – laterality, top to bottom – centering, and front to back – focus)	Motor skills are connected to learning – same brain processes are involved; balance activities improve reading and visual processes, fine motor skills (writing).	1. Balance activities develop brain integration, providing a link between physical skill development and academic learning. 2. Activities varied greatly: jumping, spinning, balance beam, etc. 3. Recommendation: Balance activities which cross the midline and stimulate all three brain dimensions should be utilized, especially in the early developmental years.

Table 1 Continued.

Focus Question 1: Does research confirm that cognitive development can be improved with exercise?
Focus Question 2: Is there a common physical activity used in the studies?
Focus Question 3: Are there any specific physical activities recommended by the studies?

Article reviewed	Methodology	Context/ Participants	Study Findings	Key Conclusion	Synthesis: Answer to Focus Question
Physical Activity and the Achievement Gap Among Urban Minority Youth (Basch, 2011)	Literature Review	None specified	No evidence to show reducing PE is a sound strategy for increasing academic achievement	PE has a positive impact on educational outcomes	1. PE has a positive effect on academic performance. 2. Types of activities were not specified. 3. The Task Force on Community Preventive Services recommends increased PE time in schools.
Physical education, school physical activity, sports and academic performance (Trudeau, Shephard, 2008)	Study Review	7 quasi-experimental and 9 cross-sectional studies	More time dedicated to PE does not have a negative impact on academic performance	PE has positive impact on educational outcomes	1. Positive correlation with small but absolute gains in academic achievement with additional PE. 2. A wide variety of activities were used. 3. Any added physical activity is beneficial.
Quality Daily Physical Education for the Primary School Student: A Personal Account of the Trois-Rivieres Regional Project (Shephard, Trudeau, 2013)	Review of Trois-Rivieres study: Intervention included integration of daily hour of specialist-taught PE	6 year intervention in the 1970's: grades 1-6 in both urban and rural settings. Control group received only standard 40 min/wk of non-specialist taught PE.	Improved academic performance and overall health of participants in the PE group	Follow ups in later years showed overall increased health in PE participants compared to control group	1. Academic performance was enhanced in students who received daily PE. 2. A wide variety of activities including running, team sports, and gymnastics. 3. An hour of cardiovascular exercise (any type) per day yields maximum benefits to students.

Table 2. Expert Interviews	
Question 1: How important is physical activity to cognitive development?	
Name	Response
Kelly McGonigal, PhD	5 minutes of physical activity decreases stress, improves mood, enhances focus, and boosts self-confidence (Barton, Pretty, 2010)[i]. The brain grows with exercise or movement…movement nurtures natural, healthy development and self-care or self-compassion (personal communication, February 13, 2014).
Dara Ghahremani, PhD	Physical activity, including yoga, breathing techniques, etc, are essential for activating cognitive and interactive processes which raise awareness and enhance concentration (personal communication, February 14, 2014).
Denise C. Pope, PhD	Free, unstructured play time is essential to cognitive development (personal communication, February 14, 2014).

Question 2: What does your research show in terms of the benefits of physical activity on increased cognitive development?	
Name	Response
Adam H. Gazzaley, MD, PhD	Physical exercise adds to the brain's plasticity. Physical fitness, aerobic exercise; these are essential to building the engine of the brain. (personal communication, February 14, 2014)
Edward M. Hallowell, MD	We must activate the brain so it can grow and flourish, so we can be happy, successful, healthy, etc (personal communication, February 14, 2014).
Denise C. Pope, PhD	Kids who walk to school do better than students who are driven to school. Movement at the beginning of the day is so important to help boost brain power and gets you ready to learn (personal communication, February 14, 2014).
Sandra M. Aamodt, PhD	Exercise has a substantial effect on self control. Anybody who's been thinking about skipping recess, this is another reason not to. In a meta-analysis of kids ages 14-18, the physically active ones scored higher on IQ, perceptual skill, verbal, math and academic readiness. An intervention study 7-11 year old sedentary children, 20-40 minutes of exercise a day substantially increased self control and pre-frontal cortex activity. Fit children show half as much interference in an incongruent task as sedentary children. The risk for Alzheimer's disease is decreased significantly in active adults. Martial arts involves physical activity with self control.

Table 2 Continued.	
Question 3: Should educators incorporate physical activity in the classroom setting?	
Name	Response
Louis J. Cozolino, PhD	Educators should help children edit the story of their lives. Life is performance art. Stress inhibits protein growth and development (personal communication, February 15, 2014).
Denise C. Pope, PhD	If you are an elementary school teacher and are not building in proper transitions with some movement and activity between lessons, you are not giving students what they need. Similarly, if you are in a secondary school with 5 minute passing period, you are not allowing kids enough time to transition. Students need time to think deeply about one thing, time to move around and reflect, and be social. It takes about 13 minutes for the brain to transfer from one subject to the next. Incorporating a movement break before starting class will allow students' brains to catch up and shift to the next subject. Build breaks into the day with movement so the brain can switch gears (personal communication, February 14, 2014).
Dara Ghahremani, PhD	Physical exercise acts as a stress reliever and helps students find healthy ways to handle stress. It also helps build a sense of teamwork and belongingness. Students learn emotional strategies and form a direct link between their breathe and their emotions (personal communication, February 14, 2014).
Edward M. Hallowell, MD	We need to maximize our children's potential. Their attitudes: confidence, grit, growth mindset, optimism, are all instilled during growth years. Children need to have connections at school. They need outings, to have fun, to be involved in clubs and activities, to have opportunities for independent play. Any activity in which the imagination lights up. They need to build muscular memory, morals, and get physically involved in their world (personal communication, February 14, 2014).
Dr. Sam J. Goldstein, PhD	It is critical for teachers to find ways for students to be physically active. Teacher behavior has effects on student results. In order to prepare students for a future we can't imagine, we must share important qualities with all children. The cortisol levels of poverty kids is elevated and puts them at an even greater disadvantage, and exercise can help counter [those levels]. Teachers are at the forefront of being able to implement these lasting traits, to engage and motivate our children. They are tasked with teaching our children the 5C's (competence, confidence, connections, character, and caring) so they can function in tomorrow's world. Getting them up and moving helps facilitate that agenda and will add to their overall functional tool box (personal communication, February 14, 2014).
Adam H. Gazzaley, MD, PhD	We must take traditional education and add meditation, cognitive training, and an enriched environment and we can boost the effects of cognitive development with physical exercise, nutrition, neurofeedback, and neuromodulation (personal communication, February 14, 2014).

Table 3. Implementation Programs		
The following is a list of programs or activities educators can implement in their classrooms.		
Publication	**Example(s) of Activity**	**Targeted Areas**
Balancing with the Brain in Mind (Stevens-Smith, 2006)	**Spinning:** Can be done standing, sitting, on knees, as part of a sequence. **Balancing:** Can be performed on ropes, beams, etc. **Crossovers:** Crossing over of arms and legs, crossing midline of body	Activates vestibular system Activates Front/Back and Left/Right brain dimensions Activates Left/Right brain dimensions
Active Education : Lessons for Integrating Physical Activity with Language Arts, Math, Science and Social Studies (Reed, 2009)	**Act Out Prepositions:** Students demonstrate the selected preposition (i.e. under, over, out) **Fun With Orbits:** Students act out the orbit of the planets around the sun	Integrates movement and language arts Integrates movement and science
Effects of the Youth Empowerment Seminar on Impulsive Behavior in Adolescents (Ghahremani, 2013)	**Youth Empowerment Seminar (YES!)** **Guided deep breathing with light stretching:** Participants reach up while inhaling, then lower their hands while exhaling in quick succession for about one minute.	Promotes increased oxygenated blood flow to the brain. Integrates movement with breathing. Energizes and refreshes, de-stresses.
Gesturing Makes Learning Last (Cook Mitchell, & Goldin-Meadow, 2008)	**Gestures:** Adding gestures while students learn new concepts.	Activates working and long-term memory.

Table 3 Continued.		
Additional Sources for Cognitive Development Centered Physical Activities		
Program Name	**Sources**	**Description**
Brain Gym (Dennison, P., Dennison, G., 1994)	www.braingym.com	26 Coordinated activities for all ages
Energizers (Mahar, 2011)	http://www.ecu.edu/cs-hhp/exss/apl.cfm	Activities by grade and subject
Walk Across Texas (Texas A&M Agrilife Extension) (Walk Across Texas, 2014)	http://walkacrosstexas.tamu.edu/tools-and-resources/teacher-lesson-plans.php	Activities by grade and subject

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[i] Dr. McGonigal cited the findings of the Barton and Pretty, 2010, University of Essex, UK