ABSTRACT

Title of Dissertation: A MULTILEVEL ANALYSIS OF THE RELATIONSHIP BETWEEN PHYSICAL EDUCATION REQUIREMENTS AND STUDENT ACADEMIC ACHIEVEMENT IN HIGH SCHOOL

Sang Min Kim, Doctor of Philosophy, 2015

Directed By: Professor Linda R. Valli
Department of Teaching and Learning, Policy and Leadership

Although national recommendations and guidelines have called for schools to play a greater role in enhancing physical activity through physical education to prevent sedentary lifestyles or physical inactivity of children and adolescents, many schools have reduced or eliminated physical education time or programs despite state or district mandates. These policies and practices are often part of schools' efforts to increase students' standardized test scores given the pressures of accountability reforms in education.

Guided by Argyris and Schön's (1974) theory of action, the effectiveness of schools' policies and practices of decreasing or eliminating physical education time or programs to improve students' academic achievement was tested in this study. In particular, this study aimed to examine the relationship between schools' physical education graduation requirements and students' academic achievement growth in reading, mathematics, and science in high school settings. To this end, the study used a multilevel analysis from a large, nationally representative sample of U.S. high schoolers from the NELS database.

Results showed that time requirements of physical education for graduation were either positively or neutrally related to student academic achievement growth in mathematics and science while time requirements of physical education for graduation had only a neutral relation to student academic achievement growth in reading, after controlling for student, family, and school characteristics. Also, there were gender differences in the relations between time requirements of physical education for graduation and student academic achievement growth in mathematics and science with no gender difference found in reading.

Overall, although there was not strong evidence that more time requirements of physical education for graduation were associated with higher student academic achievement growth, the findings of this study indicate that certain time requirements of physical education for graduation are positively associated with student academic achievement growth especially in mathematics and science. The findings of the study further imply that increased time requirements schools set aside for physical education for graduation do not decrease or compromise student academic achievement growth in the three core high school subjects.

A MULTILEVEL ANALYSIS OF THE RELATIONSHIP BETWEEN PHYSICAL EDUCATION REQUIREMENTS AND STUDENT ACADEMIC ACHIEVEMENT IN HIGH SCHOOL

By

Sang Min Kim

Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2015

Advisory Committee:
Professor Linda R. Valli, Chair
Professor Jane E. Clark
Professor Robert G. Croninger
Professor Dena A. Deglau
Professor David G. Imig

Dedication

This dissertation is dedicated to

my role model and father, Taesoo Kim, and particularly my dearly beloved mother,

Jungdeok Jung, who is brave and strong enough to fight and beat her terminal cancer.

Acknowledgements

I would like to express my deepest appreciation to my academic advisor and dissertation committee chair, Dr. Linda R. Valli, for her endless patience, useful guidance, and huge support throughout my entire dissertation process and doctoral study. Her mentorship and encouragement were paramount in helping me obtain research and educational experiences as a researcher and an educator. Next, I would like give my very special thanks to Dr. Robert G. Croninger, a dissertation committee member, who inspires me in quantitative research using a multilevel analysis and motivates me to participate in a variety of research activities. I also would like to truly thank my dissertation committee members, Dr. Jane E. Clark, Dr. Dena A. Deglau, and Dr. David G. Imig, for their extensive and insightful feedback on my dissertation. I have the privilege and honor of having all of them serve on my dissertation advisory committee.

Lastly and importantly, initiating and completing my dissertation would not have been possible without the love, patience, and support of my family. Special thanks go to my parents, sister, and brother, for always being so supportive to me in countless ways; to my wife, Yoonjeong, for her love, encouragement, and support; to my sweet daughters, Michelle and Anna, for being healthy, being happy, and understanding for all the missed play time while I studied and worked.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Statement of the Problem

There is a growing concern regarding sedentary lifestyles in U.S. children and adolescents. Many more children and adolescents spend the majority of their time sitting in classroom and doing sedentary leisure activity out of school (National Association for Sport and Physical Education [NASPE] & American Heart Association [AHA], 2012). According to the 2011 national school-based Youth Risk Behavior Survey (YRBS), for instance, nearly one third of U.S. adolescents spent three or more hours per day in television watching (32.4%) and video or computer game playing (31.1%) on an average school day (Centers for Disease Control and Prevention [CDC], 2012; Eaton, Kann, Kinchen, Shanklin, Flint, Hawkins, Harris, Lowry, McManus, Chyen, Whittle, Lim, & Wechsler, 2012). As children and adolescents are more sedentary, they are more likely to become physically inactive. The problem is that sedentary behaviors and resulting physical inactivities are closely related to major causes and high rates of disease, disability, and death in children and adolescents, which have negative impacts on the function and quality and quantity of life (Glickman, Parker, Sim, Cook, & Miller, 2012; Institute of Medicine [IOM], 2012a; NASPE, 2009f, 2009g, 2009h; National Research Council [NRC] & IOM, 2013; Woolf & Aron, 2013; World Health Organization [WHO], 2008, 2009).

Particularly, physical inactivity, along with poor diet and nutrition, has been recognized as one of the key influential factors on the prevalence of obesity in U.S. children and adolescents (e.g., Strong, Malina, Blimkie, Daniels, Dishman, Gutin, Hergenroeder, Must, Nixon, Pivarnik, Rowland, Trost, & Trudeau, 2005). Obesity rates in children and adolescents have drastically increased and thus prevalent obesity among U.S. children and adolescents has become a national health concern (IOM, 2013a; Kohl & Cook, 2013; Ogden, Carroll, Curtin, Lamb, & Flegal, 2010; Ogden, Carroll, Kit, & Flegal, 2012; Trust for America's Health [TFAH] & Robert Wood Johnson Foundation [RWJF], 2012, 2013; U.S. Department of Health and Human Services [USDHHS], 2000, 2010a, 2010b). According to the National Health and Nutrition Examination Survey (NHANES) 2009-2010, for instance, almost 17% of children and adolescents were obese in 2009-2010 and the pervasiveness of obesity was highest among adolescents aged 12–19 years, showing 18.4% obesity prevalence (Ogden et al., 2012).

As sedentary and physically inactive lifestyles, along with related diseases and obesity, have become a national health concern, many leading health, medical, and educational organizations such as Centers for Disease Control and Prevention (CDC), National Institutes of Health (NIH), Institute of Medicine (IOM), and National Education Association (NEA) have emphasized the necessity and importance of physical activity for children's and adolescents' health promotion. In 2001, for instance, the U.S. Surgeon General released the *Call to Action* to establish specific plans and actions for preventing or reducing the problems of overweight and obesity among children and adolescents (USDHHS, 2001). In order to advocate this *Call to Action,* the federal government issued millions of dollars to local education authorities and community-based organizations for developing and providing physical activity programs (including community- and school-based physical activities).

In spite of these actions to increase physical activity, prevalence of physical activity has continuously reduced among children and adolescents (e.g., NASPE & AHA, 2012). Especially, physical activity rate of female adolescent students drastically decreased (e.g., Kimm, Glynn, Kriska, Barton, Kronsberg, Daniels, Crawford, Sabry, & Liu, 2002) with female adolescents remaining less physically active than male adolescents (e.g., Gordon-Larsen, McMurray, & Popkin, 2000; Lowry, Weschler, Galuska, Fulton, & Kann, 2009). Given this, there have been increased efforts to establish evidence-based physical activity guidelines and recommendations for both male and female children and adolescents, which are enjoyable and developmentally or ability-appropriate in type, frequency, duration, and intensity including various types of activities (e.g., CDC, 2010b, 2014b; Haskell, Lee, Pate, Powell, Blair, Franklin, Macera, Heath, Thompson, & Bauman, 2007a, 2007b; Landry & Driscoll, 2012; NASPE, 2009a, 2009b, 2009c, 2009d, 2009e; Nelson, Rejeski, Blair, Duncan, Judge, King, Macera, & Castaneda-Sceppa, 2007a, 2007b; President's Council on Fitness, Sports and Nutrition [PCFSN], 2012; Strong et al., 2005; WHO, 2010). For example, the U.S. Department of Health and Human Services (USDHHS) recommended that children and adolescents participate in at least 60 minutes per day of moderate to vigorous physical activity (MVPA) to obtain multiple health benefits such as decreased likelihood of developing heart disease, type 2 diabetes, and obesity (USDHHS, 2008). The President's Council on Fitness, Sports and Nutrition (PCFSN, formerly the President's Council on Physical Fitness and Sports [PCPFS]) further proposed that 60-minute daily MVPA for youth aged 6–17 years involve vigorous aerobic, bone- and muscle-strengthening activities three days or more per week (PCFSN, 2012).

Particularly, there has been increased attention to physical education programs for all children and adolescents in grades K–12 for physical activity promotion. Since 2001, for instance, the National Association for Sport and Physical Education (NASPE) solely or in partnership with the American Heart Association (AHA) has examined the status of physical education and hence released a series of the *Shape of the Nation Report*s to offer various up-to-date information for enhancing physical education in elementary and secondary schools (NASPE, 2001a; NASPE & AHA, 2006, 2010, 2012). In 2001, the U.S. Department of Education (USED) administered the Physical Education for Progress program, called the *Carol M. White Physical Education Program* (PEP), which provided funding to local education agencies and community-based organizations to initiate, expand, and improve physical education for students in grades K–12 (Lee, Burgeson, Fulton, & Spain, 2007). Further, key national health institutions and physical education organizations such as CDC, USDHHS, and NASPE and AHA have claimed that children and adolescents should participate in daily physical education for 150 minutes per week for elementary students and for 225 minutes per week for middle and high school students of MVPA for their appropriate physical development and health (CDC, 2010c, 2010d; NASPE & AHA, 2006, 2010, 2012; USDHHS, 2000, 2008, 2010a). To this end, it has been suggested that schools take comprehensive and proactive approaches to help students accomplish the nationally recommended 60 minutes or more of daily physical activity mostly through physical education as well as recess or physical activity breaks, intramural or interscholastic sports, physical activity or sports clubs, and active commute before, during, and after school (Basch, 2011b; Beets, Beighle, Erwin & White, 2009; Beets, Huberty & Beighle, 2012; Beets, Wallner & Beighle, 2010; Beighle & Moore, 2012; CDC, 2010d, 2011b; Cooper, Page, Foster & Qahwaji, 2003; Daley, 2002; Heelan, Unruh, Combs, Donnelly, Sutton, & Abbey, 2008; Leek, Carlson, Cain, Henrichon, Rosenberg, Patrick & Sallis, 2011; NASPE, 2003, 2006b, 2007, 2008; Naylor & McKay, 2009; Powers, Conway, McKenzie, Sallis & Marshall, 2002; Rasberry, Lee, Robin, Laris, Russell, Coyle, & Nihiser, 2011; USDHHS, 2010a).

Despite these federal funded programs and national campaigns to improve physical education, physical education as a school subject has been marginalized and its allocated time or curricular programs have been substantially reduced or eliminated (Beddoes, Prusak, & Hall, 2014; CDC, 2010c; Henninger & Carlson, 2011; James, 2011; NASPE & AHA, 2006, 2010, 2012; USDHHS, 2010a). The increased emphasis of schools on enhancing students' standardized test scores has been known to be a barrier to maintain or advance physical education policies and practices (Kwak, Kremers, Bergman, Ruiz, Rizzo, & Sjöström, 2009; Sallis, McKenzie, Beets, Beighle, Erwin, & Lee, 2012). Particularly since the *No Child Left Behind* Act of 2001 (NCLB), which focuses on student achievement in defined core academic subjects such as reading and mathematics, physical education time or programs have been reduced or eliminated from school curricula and been replaced with academic courses closely related to core subjects (Donnelly & Lambourne, 2011; USDHHS, 2010a). This suggests that some school administrators and teachers believe that taking time away from physical education programs and replacing it with core academic courses, especially those tested under NCLB, may increase student academic achievement.

Schools' policies and practices of reducing or eliminating physical education time or programs to increase students' academic achievement have brought attention to the importance of exploring the relation between time allocated to physical education and student academic achievement. Most previous studies have provided evidence that the increased physical education time was positively or neutrally associated with student academic performance in elementary and middle school settings. For example, the 2010 CDC report reviewed 14 studies that examined the relation between physical education and student academic performance measured by standardized test scores, grades, or teacher ratings of students' classroom behaviors (CDC, 2010d; Rasberry et al., 2011). Based on the 2010 CDC report, only one study found a negative relation to academic performance, whereas eight studies found a positive association with academic performance. The remaining five studies revealed a mixture of positive and neutral links to academic performance. It is important to note that in most studies, the increased time in physical education did not have a negative relation to academic performance even though students spent less time in core academic subjects.

While the reasons for the positive relations with academic performance were not ascertained in previous studies, it may be partly due to the behavioral and cognitive benefits of participation in physical activity during physical education. Some researchers have reasoned that increased physical activity level during physical education reduces boredom and enhances arousal which may promote students' attention or concentration, influencing their academic achievement (e.g., Caterino & Polak, 1999; Chomitz, Slining, McGowan, Mitchell, Dawson, & Hacker, 2009; Dwyer, Blizzard, & Dean, 1996; Ericsson, 2008; IOM, 2013a; Kohl & Cook, 2013; Sallis, McJenzie, Kolody, Lewis, Marshall, & Paul, 1999; Shephard, 1996, 1997). Other researchers have reasoned that greater allocated time for physical education promotes greater physical activity which enhances physical fitness and in turn more physically fit students have more opportunities for engagement in school or academic work, along with less disciplinary problems, leading to higher academic achievement (e.g., Texas Education Agency. 2009; Tremblay, Inman, & Willms, 2000). Additionally, researchers have found that greater allocated time for physical education increases the amount of physical activity which helps the brain function effectively and enhances its cognitive development for learning (Chaddock, Pontifex, Hillman, & Kramer, 2011; Summerford, 2001; Taras, 2005; Taylor & Lamoreaux, 2008; Tomporowski, Davis, Miller, & Naglieri, 2008). These findings indicate that students who participate in more physical education classes are likely to academically perform better than those who do not. The findings further imply that schools could provide students with learning-enhanced environments by increasing the allocated time for physical education.

Considering the recent pressures of schools to increase students' academic achievement, understanding the relation between school policy on physical education time allocation and student academic achievement is crucial. Therefore, this dissertation study examines the relationship between high schools' policy requirements for physical education and students' academic achievement in core subject areas. To date, while there is evidence that allocated time for physical education and academic achievement are positively or neutrally correlated among elementary students (e.g., Ericsson, 2008; Shephard, 1996, 1997; Tremarche, Robinson, & Graham, 2007), little research has investigated the relationship among high school students. Also, few studies have examined the link of allocated time for physical education to academic achievement with a large sample. Further, few studies have explored gender difference in the association between allocated time for physical education and academic achievement among high school students. Given that high school students are required to take physical education as one of the requirements for graduation in most states in the U.S., this study sought to examine (1) the relation between a *school*'s physical education requirements, particularly years of physical education coursework required for graduation, and *students*' academic achievement after controlling for student personal characteristics and family and school environmental factors and (2) gender difference in the relation between physical education requirements and academic achievement among high school students. To this end, this study used a multilevel analysis with a large, nationally representative sample of high schoolers in the U.S.

Purpose of the Study and Research Hypotheses

With the foregoing concerns and interests in mind, the purpose of this study was threefold: first, to better understand the relationship between a school's physical education graduation requirements and students' academic achievement in high school settings; second, to investigate gender difference in the association between physical education graduation requirements and student academic achievement; third, to provide policymakers, school administrators, and other stakeholders with more insight and practical guidelines on the physical education graduation requirements. This study does differ from most of other previous studies in that it uses a multilevel analysis to examine the relation between physical education requirements (school level) and academic achievement (student level) with a large, nationally representative sample of U.S. high school students. The academic achievement focus in this study was students' achievement growth or gains in reading, mathematics, and science.

The four hypotheses of this dissertation study were:

Hypothesis 1: Students who attend schools with more physical education graduation requirements are likely to have higher academic achievement growth in reading than those who attend schools with less or no physical education graduation requirements.

Hypothesis 2: Students who attend schools with more physical education graduation requirements are likely to have higher academic achievement growth in mathematics than those who attend schools with less or no physical education graduation requirements.

Hypothesis 3: Students who attend schools with more physical education graduation requirements are likely to have higher academic achievement growth in science than those who attend schools with less or no physical education graduation requirements.

Hypothesis 4: The relationships between physical education graduation requirements and three measures of student academic achievement are likely to differ by gender.

Significance of the Study

This study is significant in that the results may be conducive to initiating and extending the literature on the relationship between a school's physical education graduation requirements and students' academic achievement in secondary school. Previous studies have increasingly and consistently found that students who spent more time in physical education were likely to have higher academic achievement in elementary school. It is not clear, however, whether physical education graduation requirements are related to student academic achievement particularly in high school. Accordingly, this study may answer this question and contribute to the literature on educational benefits of physical education on academic achievement.

Methodologically, this study is significant in at least two different ways from previous research. First, it used a large, nationally representative sample of U.S. high schoolers to examine the association between physical education graduation requirements and student academic achievement where physical education requirements were not cofounded with health education requirements. Next, the study employed hierarchical linear modeling (HLM) to conduct a multilevel analysis of the association between physical education graduation requirements (school level) and academic achievement (student level). This multilevel focus enables researchers and practitioners to better understand a comprehensive picture of family and school environmental factors as well as student individual factors that may be linked to academic achievement.

In practice, the findings of this study may provide greater insight into the relation between school policy on physical education graduation requirements and student academic achievement. Specifically, the study may contribute to more effective school policies and practices on planning and implementing physical education requirements that no longer treat physical education as a marginalized subject. These changes could result in students' higher academic achievement. And although the following results are beyond the scope of this study, previous research indicates that increased physical education could help bring about more active and healthier lives in and out of school. Given the drastic declines in both physical education requirements and participation in high school, this study may offer useful guidelines for policymakers and school administrators who make decisions about reducing, eliminating, increasing, or maintaining high school physical education time or programs.

Chapter 2: Literature Review

Theoretical Framework

Given the current situation where schools have reduced or eliminated physical education time or programs to increase students' academic achievement, it is important to examine whether the schools' current actions to increase that achievement accomplished their intended outcomes (e.g., higher standardized test scores). To this end, this study adopted Argyris and Schön's (1974) theory of action as a theoretical framework to evaluate the effectiveness of the school's action.

Argyris and Schön (1974) state that people or organizations hold two different theories of actions when they deal with certain circumstances. One is a theory of action espoused in their minds and the other is a theory of action they actually use. People or organizations hold action plans in their minds when they face certain problems. When asked about their plans to deal with those problems, people or organizations say what they believe they would do. In Argyris and Schön's (1974) term, what people or organizations think and say about their actions is referred to as *espoused theory*. However, Argyris and Schön (1974) state that people's or organizations' actual actions in reality are often not consistent with their espoused theories. According to Argyris and Schön (1974), there is another kind of theory that actually governs or determines people's or organizations' actions, which is referred to as *theory-in-use*.

Few people or organizations are aware of the theories-in-use that actually govern or determine their behaviors. Further, few people or organizations are aware of actions based on theories-in-use that are inconsistent with the theories they espouse. Argyris (1980) found, for instance, that most faculty members held espoused theories about their teaching methods. When asked about their instructional philosophies and methods by management consultants during training sessions, most faculty members responded that they emphasized learners' independence in learning processes and hence used an instructional method (e.g., case study) to enhance learners' independence by discussing and resolving several important case studies during class sessions. This represents faculty members' espoused theories regarding their teaching. Observations and tape recordings of class sessions, however, showed that most faculty members actually discouraged learners' independence and employed more controlled class structures when they implemented case study methods during class sessions. That is, most faculty members did not recognize that their actions were not accurate representations of their espoused theories.

Argyris and Schön (1974) assert that one major reason for reduced effectiveness in people's or organizations' actions is the discrepancy between their espoused theories and theories-in-use. The espoused theories people or organizations hold are used to make action plans to obtain intended outcomes. When people's or organizations' actions are inconsistent with espoused theories, however, these actions (based on their theories-in-use) may yield unintended or unwanted consequences, reducing the effectiveness of their actions. The discrepancy between espoused theories and theories-in-use may result in unintended or unwanted outcomes which may be harmful to people or organizations. In order to effectively manage actions and obtain intended outcomes, Argyris and Schön (1974) suggest minimizing the gap of these two theories by examining and improving the congruence in their theories of actions, that is, increasing the agreement between the espoused theory and the theory-in-use. To investigate the congruence, people or organizations first need to be aware of the two different theories of actions and then need to make their espoused theories and theories-in-use explicit. Given that few people or organizations are aware of the theories they actually use and that these theories are often implicit, it is difficult to make theories-in-use explicit. Argyris and Schön (1974) claim that other people's observations on people's or organizations' actions are helpful to identify the theories-in-use. Once people or organizations make their espoused theories and theories-in-use explicit, examining any incongruence between the two theories and making an effort to minimize the incongruence are important steps to effectively manage their actions.

Physical education has a long history as an official curriculum in K-12 school environment and has played a key role in helping school-age students regularly and enjoyably participate in physical activity (NASPE, 2013; Pate, Davis, Robinson, Stone, McKenzie, & Young, 2006; Sallis & McKenzie, 1991; Shephard, 1997). As an official curriculum, physical education has been recognized as an essential school curriculum and one that needs to be maintained in school settings (NASPE, 2001b, 2011; Society of Health and Physical Educators [SHAPE America], 2015). However, data presented later show that schools provide quite limited time in physical education programs. Further, since the federal educational reforms in the U.S., many schools have taken time away from physical education programs and replaced it with core academic courses. Those school actions indicate that the theories-in-use of most schools may be that physical education is a marginal or auxiliary curriculum which can be reduced or eliminated to achieve schools' other intended goals and outcomes. School administrators might not be aware that their actions on physical education policy or practice are inconsistent with the theories they actually espouse. As Argyris and Schön (1974) mentioned, the discrepancy between the schools' espoused theories and theories-in-use may reduce the effectiveness of their actions and hence result in unintended outcomes, particularly unwanted consequences on physical education programs.

Argyris and Schön (1974) also contend that another major source of hindering the effectiveness of action is the inconsistency of people's or organizations' actions. Consistency means that people's or organizations' actions to achieve desired consequences are internally compatible with each other when people or organizations design actions to achieve multiple intended outcomes. Consistency can be achieved when their actions or efforts to achieve multiple consequences do not interfere with one another. If actions are internally incompatible in a particular situation, people or organizations cannot reach high levels of achievement. When multiple theories-in-use are simultaneously enacted, the effectiveness of actions is reduced. In relation to this study, many schools deal with two major challenges: students' academic achievement improvement and health promotion. Presumably schools can take actions to achieve the two objectives at the same time. However, schools' current actions seem to be internally incompatible in that their efforts to increase students' academic achievement have been made by decreasing or eliminating physical education time or programs. According to Argyris and Schön (1974), the inconsistency of schools' actions may reduce the effectiveness of their actions to achieve their intended outcomes (e.g., higher academic achievement, better health).

Lastly, Argyris and Schön (1974) suggest that testing and evaluating the effectiveness of people's or organizations' actions to achieve their intended outcomes is an important process. By examining the effectiveness of their actions, people or organizations can learn from the results of their actions and those experiences can contribute to constructing theories of actions that in turn will guide future actions. Effectiveness is achieved when actions lead to predicted and intended results. Given that schools have tried to increase students' academic achievement by reducing or eliminating physical education time or programs, one may ask whether this school action brings about higher student academic achievement. It seems that schools' current actions of decreasing or eliminating physical education may not be academically effective because many previous studies demonstrated a positive or neutral link between physical education participation or time and student academic achievement (e.g., Carlson, Fulton, Lee, Maynard, Brown, Kohl, & Dietz, 2008; CDC, 2010d; Ericsson, 2008; Shephard, 1997). Further, some researchers have argued that current schools' actions ignore the value or benefits of physical education on students' health promotion (e.g., Le Masurier & Corbin, 2006). As Argyris and Schön (1974) would suggest, schools' current actions of reducing or eliminating physical education time or programs to enhance students' academic achievement should be tested and evaluated so that schools can effectively manage their actions to maximize intended or wanted goals and outcomes and minimize unintended or unwanted consequences.

Although physical education has received recognition for students' health promotion and potential cognitive development, one of the schools' actions was to reduce or eliminate physical education time or programs to increase students' academic achievement. Argyris and Schön's (1974) theory of action suggests the importance of examining whether these actions of schools effectively achieve their intended goals and outcomes, particularly students' academic achievement. Further, given schools' espoused goals of offering health-promoting environments as well as learning-enhancing environments, research can improve policymakers and administrators' knowledge and skills about appropriate actions that effectively achieve these multiple goals and desired outcomes. With its focus on the relationship between physical education requirements and student academic achievement, this dissertation study is designed to provide such guidance.

Physical Activity and Physical Education

Given the increased sedentary lifestyles of children and adolescents and resulting national health problems (IOM, 2013a; Kohl & Cook, 2013; USDHHS, 2000, 2001, 2010a, 2010b), physical activity and physical education have emerged as key areas of interest for public and school health officials to consider. With the great attention to physical activity and physical education, those two terms have been used interchangeably, yielding some confusion between the two terms. Therefore, it is important to make a clear distinction between the two.

Physical activity refers to any body movement via skeletal muscles that consumes energy (Caspersen, Powell, & Christenson, 1985; NIH, 1995, 1996). From this definition, physical activity can occur in various ways during daily life such as resting (e.g., sitting), studying (e.g., reading), playing (e.g., throwing & catching), and working (e.g., driving) at home, at school, at leisure, and at work. According to the *2008 Physical Activity Guidelines for Americans*, however, physical activity is defined as bodily movement that uses more energy than resting and enhances health mostly through regular moderate to vigorous and/or competitive activities such as walking, jumping rope, dancing, weight training, jogging/running, swimming, and soccer (Ainsworth, Haskell, Herrmann, Meckes, Bassett, Tudor-Locke, Greer, Vezina, Whitt-Glover, & Leon, 2011; Ainsworth, Haskell, Leon, Jacobs, Montoye, Sallis, & Paffenbarger, 1993; Ainsworth, Haskell, Whitt-Glover, Irwin, Swartz, Strath, O'Brien, Bassett, Schmitz, Emplaincourt, Jacobs, & Leon, 2000; Brown, Heath, & Martin, 2010; CDC, 2010a; PCFSN, 2003; USDHHS, 1999, 2008; WHO, 2010). Based on a recent series of the NASPE guidelines, from an educational perspective, physical educators define physical activity as "the content and product of the physical education program" (NASPE, 2009b, p. 5, 2009c, p. 6), which is an important element of physical education subject matter within the school (NASPE, 2009a).

Scientific evidence has continued to support substantial health benefits of physical activity including preventive obesity and reduced anxiety and depression (e.g., CDC, 2008, 2010b, 2014b; Hassmén, Koivula, & Uutela, 2000; Kushi, Byers, Doyle, Bandera, McCullough, Gansler, Andrews, & Thun, 2006). In response to this, the nationwide key health objectives of the *Healthy People 2020* aimed to increase schools that require daily physical activity for grades K–12 students (USDHHS, 2010a). Also, First Lady Michelle Obama started the *Let's Move!* Active Schools, part of the *Let's Move!* campaign, in partnership with and support from national health (e.g., Alliance for a Healthier Generation [AHG], PCFSN, USDHHS) and physical education (e.g., SHAPE America) organizations (Beighle & Morrow, 2014; Let's Move!, 2010; Let's Move! Active Schools, 2013; Obama, 2012a, 2012b; SHAPE America, 2013d; The White House, 2010, 2013). The main strategies of this program are to promote a healthier lifestyle of the nation's youth and to achieve academic success by increasing physical activity opportunities as well as by providing more nutritious food and better health services within school and in the school community (Beighle & Morrow, 2014; Let's Move!, 2010; Katz, 2012; Let's Move! Active Schools, 2013; Obama, 2012a, 2012b; SHAPE America, 2013d; The White House, 2010, 2013). Specifically, the *Let's Move!* Active Schools recommended that schools create active environments to help students get a total of 60 minutes of daily physical activity before, during, and after the school day (Let's Move! Active Schools, 2013; SHAPE America, 2013d; The White House, 2010, 2013). Additionally, the Centers for Disease Control and Prevention (CDC) in collaboration with the Society of Health and Physical Educators (SHAPE America, formerly the American Alliance for Health, Physical Education, Recreation and Dance [AAHPERD]) suggested that all the school-age children and adolescents engage in the Comprehensive School Physical Activity Program (CSPAP) to be healthier students and better learners, implying the increasingly important roles of schools as well as families and communities (Basch, 2011a, 2011b; CDC, 2011b, 2013a, 2014a; NASPE, 2008; NEA, 2010; Naylor & McKay, 2009; PCFSN, 2012; SHAPE America, 2013a; Siedentop, 2009; Story, Nanney, & Schwartz, 2009; USDHHS, 2010b).

Physical education, as the foundation of the CSPAP and a uniquely positioned curricular component, is a planned instructional program taught by qualified physical educators in school settings, which is developmentally appropriate or relevant for all students and is a crucial part of a total school or complete education for whole-student development and growth (Mandigo, Francis, Lodewyk, & Lopez, 2009; NASPE, 2001b, 2004, 2009a, 2009b, 2009c, 2009f, 2009g, 2009h, 2011; SHAPE America, 2013b, 2013c, 2013e, 2014, 2015; Tremblay & Lloyd, 2010). Physical education focuses on physical (psychomotor) development, along with integration of emotional (affective), social, and intellectual (cognitive) aspects, for the whole student (NASPE, 2009a, 2009b, 2009c, 2009e; SHAPE America, 2014). The common goals of physical education are to help students improve their physical fitness, health- or sport-related knowledge, motor skills, behavioral skills, and confidence needed to acquire and maintain an active and a healthy lifestyle inside and outside school (NASPE, 2004, 2009a, 2009b, 2009c, 2013; Pate et al., 2006; SHAPE America, 2013a, 2013c, 2014). Specifically, the ultimate purpose of physical education is to help school-age students regularly and enjoyably participate in physical activity and hence become physically educated or literate and active for a lifetime (Castelli, Centeio, Beighle, Carson, & Nicksic, 2014; Mandigo et al., 2009; NASPE, 2004, 2009a, 2009b, 2009c, 2009f, 2009g, 2009h, 2013; SHAPE America, 2013a, 2013b, 2013c, 2013e, 2014; Tremblay & Lloyd, 2010).

Given that children and adolescents spend a considerable amount of time at school, physical education has been recognized as one of the most important environments in enhancing students' physical activities (e.g., CDC, 2011b; PCFSN, 2012; Sallis & McKenzie, 1991; SHAPE America, 2013a). Leading physical education organizations such as SHAPE America and NASPE or in collaboration with AHA have called for schools to be more proactive in promoting physical education programs to increase students' physical activities, thus contributing to school health for children and adolescents (NASPE, 2001a; NASPE & AHA, 2006, 2010, 2012; SHAPE America, 2013a). NASPE and AHA have proposed, for instance, that schools provide daily physical education or at least 150 minutes per week of physical education for elementary students and 225 minutes per week of physical education for secondary students of MVPA to help school-age students accomplish the nationally recommended physical activity level (NASPE & AHA, 2006, 2010, 2012).

Although children and adolescents can get their physical activities through recess, extracurricular sports, and after-school physical activities within school contexts, physical education has been regarded as an ideal venue or hub to promote physical activity for all school-age students (e.g., CDC, 2013a, 2014a; NASPE, 2009a, 2009b, 2009c; Sallis & McKenzie, 1991; SHAPE America, 2015). That is, physical education is the only place for all students required to participate in structured physical activity regardless of their socio-demographic backgrounds (e.g., gender, race/ethnicity, SES) and other social environmental factors (CDC, 2011a, 2011b; Glickman et al., 2012; IOM, 2012a; NASPE, 2009b, 2009c; Naylor & McKay, 2009; Sallis et al., 1999; Sallis et al., 2012; SHAPE America, 2013a; Shephard, 1997; USDHHS, 2010b; Xu, Chepyator-Thomson, Liu, & Schmidlein, 2010). Given this, it has been recently claimed that physical education should not only be a "cornerstone of school-based physical activity programs" (Basch, 2011b, p. 629), but also be incorporated and federally designated as a core subject including more classes and longer time in elementary and secondary schools (e.g., CDC, 2011b; Gambescia, 2006; IOM, 2013a; Kohl & Cook, 2013). All in all, physical education helps increase regular physical activity, promote an active lifestyle, along with reduced obesity, maintain good health, and facilitate cognition for learning (e.g., NASPE, 2009b, 2009c, 2009f, 2009g, 2009h; Sallis & McKenzie, 1991; Shephard, 1997).

Educational Reform and Status of Physical Education Requirements

In recent years, NCLB has been the most significant component of the federal educational reform efforts in the U.S. (e.g., Mehta, 2013). It aimed to provide “higher quality, more accountable, and more equitable” (Meier & Wood, 2004, p. xi) education for all students and mandated that all public school students be proficient in reading and mathematics by 2014 as determined by test results at designated grade levels (grades 3–8 and once in high school) (e.g., Jennings & Bearak, 2014). Schools have been evaluated by students’ academic achievement on reading and mathematics standardized tests. If schools failed to make *adequate yearly progress* (AYP) and were classified as *needing improvement*, they received sanctions—from allowing students to move to other schools to being restructured (e.g., Mills, 2008). Consequently, this educational policy led to increased pressure on local legislators, school administrators, and teachers to enhance students’ test scores in core academic subjects (e.g., Darling-Hammond, 2004). In order to improve standardized test scores particularly in reading and mathematics, schools attempted to increase more time in core subjects for students’ higher academic achievement, resulting in reduced time in other non-tested subjects (Abrams, Pedulla, & Madaus, 2003; Wilkins, Graham, Parker, Westfall, Fraser, & Tembo, 2003). For example, 71% of districts reduced time allotted to subjects not tested under NCLB (so called low-stakes subjects) in elementary school (Jennings & Rentner, 2006).

Even with recent waivers from the U.S. Department of Education, high-stakes state testing is still mandated in core academic subjects at most grade levels. As a result, one curricular area that continues to be considered for reduced time or elimination is physical education (Gambescia, 2006; Jennings & Rentner, 2006; NASPE & AHA, 2006, 2010, 2012; Wilkins et al., 2003). Physical education time or programs indeed have been reduced or eliminated from school curricula and been replaced with academic courses closely linked to core subjects such as reading and mathematics (Donnelly & Lambourne, 2011; USDHHS, 2010a). Further, requirements for students' participation in physical education have continuously declined in schools (Burgeson, Wechsler, Brener, Young, & Spain, 2001, 2003). Although the importance of physical education programs has been recognized outside the school system, opportunities and time for students to engage in physical education have been threatened inside the school system (NASPE, 2001a; NASPE & AHA, 2006, 2010, 2012; Thomas, 2004).

In response to the need for physical education promotion, two important national surveys have been conducted to examine the status of physical education including requirements and policies in the U.S. One national survey was co-conducted by NASPE and AHA. These two associations have collected nationwide data on physical education status from education officials in all 50 states plus the District of Columbia and then released information on physical education requirements and policies at the state level in the 2012 *Shape of the Nation Report* (NASPE & AHA, 2012). For another national survey, CDC has gathered nationwide data on physical education status from education agencies in 50 states plus the District of Columbia and then released information on physical education requirements and policies at the school level in SHPPS 2006 and at the district level in the School Health Policies and Practices Study (SHPPS) 2012, formerly the School Health Policies and Programs Study (CDC, 2013b; Lee et al., 2007; Lee, Nihiser, Fulton, Borgogna, & Zavacky, 2013). The findings of these national surveys revealed that the status of elementary and secondary physical education requirements, including weekly frequency and duration, was far below the national objectives and recommendations of physical education programs at the state and school levels (Lee et al., 2007, 2013; NASPE & AHA, 2012).

In 2010, the National Governors Association Center for Best Practices (NGACBP) and the Council of Chief State School Officers (CCSSO) in collaboration with 48 states developed and released the new state-led educational initiative, called the *Common Core State Standards* (CCSS) as the latest educational movement, focusing on English/language arts (ELA) and mathematics in K–12 schools (Confrey & Krupa, 2010; Gamson, Lu, & Eckert, 2013; Kober & Rentner, 2011; NGACBP & CCSSO, 2010; Porter, McMaken, Hwang, & Yang, 2011). Despite the controversy, to date, the CCSS are officially adopted and implemented in 45 states, the District of Columbia, and four territories to provide students with high-quality education aiming for academic and career success (NGACBP & CCSSO, 2010; Williamson, Fitzgerald, & Stenner, 2013). Similar to NCLB, however, there has been an increasing challenge and concern that the CCSS urged schools to raise academic standards and to pursue high student achievement in core subjects with little consideration of or attention to students' physical activities, health, and well-being, with physical education still being marginalized (e.g., Beddoes et al., 2014; Gamson et al., 2013; Henninger & Carlson, 2011; James, 2011; Kober & Rentner, 2011; Sports, Play, and Active Recreation for Kids [SPARK], 2013a, 2013b; SPARK & Association for Supervision and Curriculum Development [ASCD], 2013).

Given the current federal and state-led educational reforms or policies and their impacts on or relations to physical education programs, it is timely to consider the status of elementary and secondary physical education requirements across the U.S. The general or specific status of physical education requirements may provide policymakers, school administrators, and other stakeholders with updated useful information and hence help them better understand the relationship between secondary physical education requirements, particularly high school physical education requirements for graduation, and student academic achievement.

Physical Education Requirement Status in Elementary School

The 2006 SHPPS data showed that 69.3% of elementary schools required students to take physical education for graduation or promotion (Lee et al., 2007). Specifically, only 57.2% to 61.1% of elementary schools required physical education for each of the grades 1–5 students. SHPPS 2006 further found that few elementary schools offered the recommended amount of physical education time for students (i.e., 150 min./week). For example, only 3.8% of elementary schools provided students with daily physical education or its equivalent and only 13.7% of elementary schools offered physical education at least three days per week or its equivalent for the entire school year in all grades. Based on the results from SHPPS 2012, the percentage of elementary physical education requirements at the district level reached 93.6% and 78.3% of districts mandated a specific amount of time for elementary physical education (Lee et al., 2013). However, the specified amount of elementary physical education time at the district level was neither surveyed nor reported.

According to the 2012 *Shape of the Nation Report*, 41 states and the District of Columbia mandated physical education programs in elementary school (NASPE & AHA, 2012). Although most states seemingly mandated elementary physical education, the mandated amount of physical education time was not actually met in many states against the national recommendations, which is a minimum of 150 minutes per week for elementary students (CDC, 2010c, 2010d; NASPE & AHA, 2006, 2010, 2012; USDHHS, 2000, 2008, 2010a). As shown in Table 1, only four states (Alabama, Florida, Louisiana, New Jersey) mandated at least 150 minutes per week or its equivalent of physical education in elementary school. Also, only one state (Illinois) mandated daily physical education, but did not mandate a specific amount of physical education time in elementary school. Moreover, 24 states and the District of Columbia mandated physical education with no specific amount of time and nine states (Alabama, Colorado, Kentucky, Michigan, Nevada, Oregon, South Dakota, Texas, Wyoming) did not mandate any physical education in elementary school. All these findings revealed that the state-mandated and school-required amount of physical education time failed to fully meet the recommended amount of physical education time for elementary students.

Table 1

Physical Education Requirements in Elementary School at the State Level

PE Requirements	No. of State	State Name
Daily (minimum 30 min./day)	1	AL
Daily w/o minimum min.	1	IL
Minimum 150 min./week	3	FL, LA, NJ
Minimum 120 min./week	1	NY
Minimum 100 min./week	1	CA
Minimum 90 min./week	1	WV
Minimum 60 min./week	3	AR, OK, SC
Minimum 50 min./week	2	MS, MO
Minimum 30 min./week	1	HI
Maximum 119 min./week	1	ND
Average 100 min./week	2	RI, WA
Mandate w/o minimum min.	25	AZ, CT, DE, DC, GA, ID, IN, IA, KS, ME, MD, MA, MN, MT, NE, NH, NM, NC, OH, PA, TN, UT, VT, VA, WI
No mandate	9	AK, CO, KY, MI, NV, OR, SD, TX, WY
Total	51	

Note. (Source: NASPE & AHA, 2012)
For simplicity, the abbreviated federal district/state name is used.
NJ: PE requirements are combined with health/safety education requirements.
RI: PE requirements are combined with health education requirements.

Physical Education Requirement Status in Middle School

The 2006 SHPPS data showed that 83.9% of middle schools required students to take physical education for graduation or promotion (Lee et al., 2007). SHPPS 2006 found, however, that only 65.5% to 68.1% of middle schools indeed required physical education for each of the grades 6–8 students. SHPPS 2006 further found that few middle schools offered the recommended amount of physical education time for students (i.e., 225 min./week). For example, only 7.9% of middle schools provided students with daily physical education or its equivalent and only 15.2% of middle schools offered physical education a minimum of three days per week or its equivalent for the entire academic year in all grades. Based on the results from SHPPS 2012, the percentage of middle school physical education requirements at the district level reached 91.9% and 72.0% of districts mandated a specific amount of time for middle school physical education (Lee et al., 2013). However, the specified amount of middle school physical education time at the district level was neither surveyed nor reported.

According to the 2012 *Shape of the Nation Report*, 40 states and the District of Columbia mandated physical education programs in middle school (NASPE & AHA, 2012). Although most states seemed to mandate middle school physical education, the mandated amount of physical education time was not truly met in many states against the national recommendations, which is a minimum of 225 minutes per week for middle school students (CDC, 2010c, 2010d; NASPE & AHA, 2006, 2010, 2012; USDHHS, 2000, 2008, 2010a). As shown in Table 2, only three states (Montana, Utah, West Virginia) mandated at least 225 minutes per week or its equivalent of physical education in middle school. Also, only one state (Illinois) mandated daily physical education, but did not mandate a specific amount of physical education time in middle school. Moreover, 25 states and the District of Columbia mandated physical education without a specific amount of time and 10 states (Alabama, Alaska, Colorado, Kentucky, Michigan, Nevada, Oregon, South Dakota, Texas, Wyoming) did not mandate any physical education in middle school. All these findings revealed that the state-mandated and school-required amount of physical education time failed to fully meet the recommended amount of physical education time for middle school students.

Table 2

Physical Education Requirements in Middle School at the State Level

PE Requirements	No. of State	State Name
Daily (minimum 30 min./day)	0	–
Daily w/o minimum min.	1	IL
Minimum 225 min./week	3	MT, UT, WV
Minimum 200 min./week	1	CA
Minimum 150 min./week	2	LA, NJ
Minimum 90 min./week	1	NY
Minimum 60 min./week	1	AR
Minimum 50 min./week	1	MS
Minimum 45 min./week	2	MO, ND
1 class period/day for 1 semester	1	FL
Average 100 min./week	2	RI, WA
Mandate w/o minimum min.	26	AZ, CT, DE, DC, GA, HI, ID, IN, IA, KS, ME, MD, MA, MN, NE, NH, NM, NC, OH, OK, PA, SC, TN, VT, VA, WI
No mandate	10	AL, AK, CO, KY, MI, NV, OR, SD, TX, WY
Total	51	

Note. (Source: NASPE & AHA, 2012)
For simplicity, the abbreviated federal district/state name is used.
NJ: PE requirements are combined with health/safety education requirements.
VA: Most school divisions allow PE as an elective in 8th grade.

Physical Education Requirement Status in High School

The 2006 SHPPS data showed that 95.2% of high schools required students to take physical education for graduation or promotion (Lee et al., 2007). SHPPS 2006 found, however, that a low percentage of high schools indeed required physical education for each of the grades 9–12 students. Specifically, only 20.2% to 33.2% of high schools required physical education for grades 10–12 students while only 55.3% of high schools required physical education for grade 9 students. SHPPS 2006 further found that few high schools offered the recommended amount of physical education time for students (i.e., 225 min./week). For example, only 2.1% of high schools provided students with daily physical education or its equivalent and only 3.0% of high schools offered physical education at least three days per week for the entire school year in all grades. Based on the results from SHPPS 2012, the percentage of high school physical education requirements at the district level reached 92.4% and 79.8% of districts mandated a specific amount of time for high school physical education (Lee et al., 2013). However, the specified amount of high school physical education time at the district level was neither surveyed nor reported.

According to the 2012 *Shape of the Nation Report*, 43 states and the District of Columbia mandated physical education programs in high school (NASPE & AHA, 2012). Among the high schools requiring physical education, students were required to take physical education as one of the requirements for graduation in many states. As shown in Table 3, among those states mandating physical education as one of the graduation requirements in high school, 38 states and the District of Columbia mandated a specific number of credits, courses, or semesters: 0.5 credit for 9 states, 1 credit for 18 states, 1.5

credits for 4 states, 2 credits for 5 states, and 15 credits for 1 state as well as 2 courses for 1 state and 1 semester for 1 state. New Jersey had the highest physical education requirements of 15 credits during a traditional 4-year high school period. Additionally, among five states mandating physical education as a high school graduation requirement, four states (Illinois, Massachusetts, Oklahoma, Rhode Island) did not mandate a specific number of credits, courses, or semesters and one state (Pennsylvania) focused instead on the standards. Moreover, seven states (Alabama, Arizona, Colorado, Idaho, Minnesota, Nebraska, Wyoming) did not mandate any physical education as a high school graduation requirement. Given these state-level data, more than half of states mandated high schools to have students take one year or less physical education for graduation.

Although most states appeared to mandate high school physical education, along with the specified number of credits, courses, or semesters, the mandated amount of physical education time was not really met in many states against the national recommendations, which is a minimum of 225 minutes per week for high school students (CDC, 2010c, 2010d; NASPE & AHA, 2006, 2010, 2012; USDHHS, 2000, 2008, 2010a). As shown in Table 3, only one state (Montana) mandated at least 225 minutes per week or its equivalent of physical education in high school. Also, only one state (Illinois) mandated daily physical education, but did not mandate a specific amount of physical education time in high school. All these findings revealed that the state-mandated and school-required amount of physical education time failed to fully meet the recommended amount of physical education time for high school students.

Furthermore, the results of SHPPS 2006 showed that many high schools allowed students to be exempted or waivered from required physical education which is valid for one grading period or longer (Lee et al., 2007). More recently, the findings of both the 2010 and 2012 *Shape of the Nation Report*s revealed that more than half of states permitted districts or schools to grant substitutions and/or exemptions or waivers for physical education time or credit requirements (NASPE & AHA, 2010, 2012). Specifically, 31 states and the District of Columbia in 2010 and 32 states and the District of Columbia in 2012 allowed school districts or schools to grant substitutions. Also, 29 states and the District of Columbia in 2010 and 27 states and the District of Columbia in 2012 allowed school districts or schools to grant exemptions or waivers.

Commonly acceptable reasons for opting not to participate in physical education often involve engagement in sports or other activities such as interscholastic sports, cheerleading, marching band, community sports, and Junior Reserve Officer Training Corps (JROTC) for substitutions as well as various issues or problems such as poor health, physical, cognitive, or medical disorder, religious observance, positive, passing, or high physical fitness test scores, and early graduation for exemptions or waivers (Lee et al., 2013; NASPE & AHA, 2010, 2012). Given this, NASPE and AHA (2006, 2010, 2012) have warned that these policies on substitutions and exemptions or waivers for physical education requirements continued to reduce the effectiveness of state-level mandates and hence recommended that the requirements for high school graduation meet the minimum standards of physical education. Additionally, Lee, Nihiser, Fulton, Borgogna, and Zavacky (2013) argued that “exemptions decrease the perceived importance of and support for participation in physical education for all students and also reduce opportunities for students to accumulate more physical activity in their daily lives” (p. 45). NASPE (2006a) and CDC (2011a) further attempted to prevent substitutions and waivers or exemptions from physical education requirements. However, the results of SHPPS 2012 showed that the percentage of districts permitting student exemptions from high school physical education requirements for at least one grading period due to religious beliefs decreased from 33.8% in 2000 to 13.7% in 2012 (Lee et al., 2013).

Table 3

Physical Education Requirements in High School at the State Level

PE Requirements	No. of State	State Name
15 credits	1	NJ
2 credits	5	IN, NV, NY, VA, WA
1.5 credits	4	LA, UT, VT, WI
1 credit	18	AK, CT, DE, DC, FL, HI, IA, KS, ME, MO, MT, NH, NM, ND, OR, SC, TX, WV
0.5 credit	9	AR, GA, KY, MD, MI, MS, OH, SD, TN,
2 courses	1	CA
1 semester	1	NC
Mandate w/o minimum credit/course/semester	5	IL, MA, OK, PA, RI
No mandate	7	AL, AZ, CO, ID, MN, NE, WY
Total	51	

Note. (Source: NASPE & AHA, 2012)
For simplicity, the abbreviated federal district/state name is used.
AL: State mandates a 1-credit personal wellness course (i.e., Lifelong Individualized Fitness Education) for graduation.
AK, KS, MT, VA, WA: PE requirements are combined with health education requirements.
HI: State mandates minimum 200 min./week of PE for graduation.
IL: State mandates daily PE without a specific no. of credits/courses/semesters for graduation.
MA: State mandates PE without a specific no. of credits/courses/semesters for graduation.
MT: State mandates minimum 225 min./week of PE.
NE: Local control and decision on graduation requirements. The majority of high schools require at least 1 semester (1 credit) of PE for graduation.
NJ: PE requirements are combined with health/safety education requirements.
OK: State mandates PE without a specific no. of credits/courses/semesters for graduation.
OR: Local control and decision on exemptions/waivers for PE.
PA: State focuses on its own PE standards rather than PE credit required for graduation.
RI: State mandates PE without a specific no. of credits/courses/semesters for graduation.
UT: PE requirements include a 0.5-credit personal wellness course (i.e., Fitness for Life) for graduation.

Summary of Physical Education Requirement Status

The federal and state-led educational reforms or policies (i.e., NCLB, CCSS) have created negative consequences for physical education by decreasing time and resources or eliminating programs and, hence, resulted in the increased marginalization of physical education as a school subject. The current U.S. educational environment stressed stronger accountability and higher achievement, focusing mainly on core academic subjects such as reading and mathematics. However, these educational reforms or policies had little consideration of or attention to students' physical activities, along with marginalized physical education, and neglected to address the debilitating condition of the nation's youth and the links between physical education, health, and academic achievement (e.g., Gamson et al., 2013; Kober & Rentner, 2011; Pühse & Gerber, 2005; Sallis, 2010; SPARK, 2013a, 2013b; SPARK & ASCD, 2013).

As reported in two national surveys on the status of physical education requirements, the status of elementary and secondary physical education requirements including weekly frequency and duration was far below the national objectives and recommendations of physical education at the state and school levels (Lee et al., 2007, 2013; NASPE & AHA, 2012). Despite high percentages of states and districts mandating physical education, low percentages of elementary and secondary schools (especially high school) required students to take physical education in each grade (Lee et al., 2007, 2013; NASPE & AHA, 2012). It is also noteworthy that the mandated amount of physical education time did not fully meet the national recommendations in many states and schools, which was markedly below 150 minutes per week for elementary students and 225 minutes per week for secondary students (CDC, 2010c, 2010d; NASPE & AHA, 2006, 2010, 2012; USDHHS, 2000, 2008, 2010a). Both elementary and secondary schools fell short of these recommendations and particularly high schools failed more than elementary and middle schools (e.g., Lee at al., 2007; Nader, 2003). Specifically, a low percentage of high schools required students (especially grades 10–12) to take physical education and few high schools offered physical education daily or three days per week as compared to elementary and middle schools. All these findings indicate differences in elementary and secondary physical education requirements between the state/district level and the school level.

In line with the lower physical education requirements in high school, along with lower weekly frequency and duration, participation in physical activity decreased especially for high school students (CDC, 2004) and both the proportions of overweight adolescents and students enrolled in no physical education increased (Thomas, 2004). Accordingly, the current problems such as physical inactivity and predominant obesity in adolescents may be partly explained by the low levels of physical education requirements and participation in high school. Given that schools play a crucial role in improving and maintaining physically active lifestyles for students, physical education may be an essential curriculum or even should be another core subject in promoting students' health and academic achievement.

Physical Education and Student Academic Achievement

The current federal and state-led educational initiatives (i.e., NCLB, CCSS) emphasizing core academic subjects such as reading/ELA, mathematics, and science have influenced schools' environment and curricular policy especially on physical education in a negative way. The school districts or schools that considered decreasing or decreased time in physical education seemingly believed that reducing or eliminating physical education time or programs and replacing them with core academic courses might improve students' test scores or grades. In response to this, physical education researchers and practitioners have sought to demonstrate the benefit of physical education on student academic achievement (e.g., Lee et al., 2013). Previous studies have illustrated that students who were more active and participated in more physical education had faster information processing and higher or longer attention and, hence, academically performed better than those who were less active and participated in less or no physical education (e.g., IOM, 2013a; Kohl & Cook, 2013). However, most of these studies have been conducted in elementary school with small samples, thus requiring more interest and research in secondary school with large samples or participants at multiple levels. Secondary schools further appeared to decrease time or eliminate programs in physical education despite the benefit of physical education and state or district mandates. Therefore, more studies are needed to examine whether school policy on allocated time for physical education is associated with student academic achievement in secondary school settings, particularly for high school or late adolescents.

The following subsections describe previous studies that explored the association between physical education participation or time and academic performance in elementary through secondary school. It should be noted that time in or for physical education can be determined by either students' engaged time in physical education or *schools' allocated time* for physical education. Although these two terms have been often used interchangeably in the relevant literature, they are different and hence should be distinctive for better examination and understanding of the relationship. Specifically, as the term indicates, engaged time in physical education is more likely to be student oriented as an individual voluntary participation while allocated time for physical education is more likely to be *school centered* as a *policy requirement* particularly in this dissertation study. For the purpose of this study, the following subsections focused mainly on previous research that investigated the relation between schools' allocated time for physical education and students' academic performance even though few relevant studies existed in secondary school, especially high school physical education settings.

Physical Education and Academic Achievement in Elementary School

There is some evidence that reducing or eliminating physical education time or programs and replacing them with core academic courses may not improve student academic achievement in elementary school. For example, Wilkins, Graham, Parker, Westfall, Fraser, and Tembo (2003) examined the relation between schools' allocated time for physical education and school-level academic performance with 547 elementary principals. School academic performance was measured by the percentage of 3rd-grade and 5th-grade students who passed the state tests in English, mathematics, science, and history/social studies. Results showed that there was no significant association between physical education time allocation and school academic performance after adjusting for schools' socio-demographic contexts (e.g., household income, racial/ethnic composition, educational level in the community surrounding schools). Therefore, the researchers concluded that the reduced allocated time for physical education was not related to the increased school academic performance.

Other researchers have also found no relationship between allocated time for physical education and students' academic performance. Dwyer, Blizzard, and Dean (1996), for instance, compared academic achievement measured by reading and arithmetic test scores and classroom behaviors measured by teacher ratings, respectively, across three intervention conditions with 5th-grade students (N = 463 in reading, N = 501 in math, N = 380 for classroom behavior) from 21 classes in seven elementary schools. Each class was randomly assigned to one of three study groups (i.e., fitness, skill, control). Students in the fitness group received 75 minutes of daily physical education with an emphasis on the intensity level of physical activity. Students in the skill group received 75 minutes of daily physical education with no focus on the intensity level of physical activity. Students in the control group received three 30 minutes of physical education per week. The intervention was conducted over 14 weeks. Dwyer and colleagues found no significant differences in achievement test scores in reading and arithmetic across three intervention conditions even though students in the fitness and skill groups had less classroom learning time to accommodate the increased time for physical education than those in the control group. Interestingly, however, the researchers found that classroom behaviors (e.g., classroom attention) improved especially for students in the two intervention groups who participated in daily physical education as compared to those in the control group. These results indicate that the increased allocated time for physical education may be a beneficial way to promote students' academic behaviors even though there is no positive effect of the increased time in physical education on student academic achievement.

More recent experimental studies have found a positive relation between allocated time for physical education and students' academic achievement in elementary school settings. To illustrate, Ericsson (2008) examined the association between the increased time in physical education and achievement scores in reading, writing, and mathematics tests with 251 grades K–2 students from one elementary school. Students in the intervention group received daily physical education classes and also intermittently received one extra class per week for motor training. In contrast, students in the control group received two physical education classes per week. Results showed that students who engaged in daily physical education had significantly higher achievement scores in reading and mathematics tests than those in the control group. Ericsson concluded that there was a positive association between more participation in physical education and student attention as an indicator of cognitive functioning even though the observed positive association might be confounded with motor training.

Another interventional study by Shephard (1996) illustrated that students who attended daily physical education equaled or had higher academic achievement in achievement measures (i.e., overall GPA, Wechsler Intelligence Scale for Children [WISC], Goodenough test) than those who did not. In the Trois Riviéres experiment including 546 elementary students in Québec in Canada, students in the experimental group received daily physical education lasting one hour per class. On the contrary, students in the control group received ordinary physical education and received 13% – 14% more learning time on academic courses than those in the experimental group. One measure for student academic achievement was overall GPA provided by homeroom teachers at the end of the school year. Results showed that students in the experimental group had higher overall GPA than those in the control group in grades 2, 3, 5, and 6, whereas no significant difference was found in GPA between students in the two groups in grades 1 and 4. Two other achievement measures were used, such as the WISC and Goodenough test. Specifically, the WISC consisted of a verbal section (e.g., comprehension, information, vocabulary, etc.) and a non-verbal section (e.g., picture completion, picture arrangement, etc.). Students in the experimental group had higher test scores in the verbal section than those in the control group. No significant difference was found in the non-verbal section between the two groups even though the test scores in the non-verbal section were favored to the experimental group.

Other recent observational studies have demonstrated a positive association between schools' allocated time for physical education and students' academic achievement. As an illustration, Tremarche, Robinson, and Graham (2007) investigated the effect of physical education time allocation on academic achievement with 311 4th-grade students from two schools in Massachusetts. While one school offered students 28 hours of physical education per year, the other school provided students with 56 hours of physical education per year. The academic achievement of two schools was measured by English, language arts, and mathematics tests through the Massachusetts Comprehensive Assessment System (MCAS). Results showed that participating students in the 56-hour physical education per school year scored significantly higher on the Massachusetts standardized tests in English and language arts than non-participating students in the 28-hour physical education per school year. No significant difference was found in mathematics test scores between the two groups. However, the observed relation between physical education and academic achievement might be confounded with students' academic backgrounds because schools' prior academic composition (i.e, average academic performance) was not controlled in the analysis.

Another observational study by Carlson, Fulton, Lee, Maynard, Brown, Kohl, and Dietz (2008) provided evidence that the increased time in physical education was related to students' higher academic achievement, especially for girls, holding students' socio-demographic backgrounds and prior academic achievement constant. Carlson and colleagues analyzed large-scale data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998 to 1999 (ECLS-K), which includes a nationally representative sample of U.S. kindergarten and elementary (1st-, 3rd-, and 5th-grade) students (N = 5,316). Time spent in physical education (min./week) was collected from classroom teachers and student academic achievement (i.e., reading, math) was scored on an item response theory (IRT) scale. Students were grouped into three categories: students enrolled in high amount (70-300 min./week), medium amount (36-69 min./week), and low amount (0-35 min./week) of physical education. Results showed that both kindergarten and 1st-grade girls who received the medium and high amounts of physical education had significantly higher reading and mathematics test scores than those who got the low amount of physical education after adjusting for students' socio-demographic backgrounds (i.e., race/ethnicity, family income, mother's education) and prior academic achievement. Also, 5th-grade girls in the medium- and high-amount physical education groups displayed higher reading test scores than those in the low-amount physical education group, holding students' socio-demographics and prior academic achievement constant. However, no significant association was found between the medium and high amounts of physical education and academic achievement among boys, indicating that girls might academically gain more from participating in physical education than boys.

Overall, although a few studies have illustrated that time allocated to physical education has a neutral relation to students' academic achievement, many more studies have demonstrated that allocated time for physical education was positively related to student academic achievement in elementary school settings. The findings of previous studies indicate that elementary students having more time in physical education than usual did not have any loss in academic achievement. Instead, elementary students who took more physical education might gain more educational benefits than those who took less or no physical education in terms of the increased academic achievement and positive classroom behaviors.

Physical Education and Academic Achievement in Secondary School

Unlike elementary school, there has been little research on the relationship between time allocated to physical education and student academic achievement in secondary school along with one of the few studies, which was performed by Coe, Pivarnik, Womack, Reeves, and Malina (2006). Coe and colleagues compared students' academic achievement measured by standardized tests and combined GPAs in English, mathematics, science, and world studies, which was based on students' enrollment status of physical education and intensity level of physical activity during physical education. Participants were 214 6th-grade students from one middle school and all students were randomly assigned to four groups. Two groups comprising approximately half of 214 students were randomly chosen, and were enrolled in and received daily physical education lasting 55 minutes per day for the first semester, whereas the other half were enrolled in and received daily arts or computer education lasting 55 minutes per day for the first semester. For the second semester, students enrolled in physical education during the first semester, in turn, took either arts or computer education while students enrolled in either arts or computer education during the first semester, in turn, took physical education. Results showed that both the standardized test scores and combined GPAs were not affected by physical education enrollment status during the first and second semesters. However, it is noteworthy that students who participated in vigorous physical activity had significantly higher GPA than their counterparts during both the first and second semesters even though no significant difference was found in standardized test scores across groups. The researchers concluded that the enrollment status of physical education might not influence student academic achievement, but the vigorous-intensity physical activity during physical education might be positively related to academic achievement.

Furthermore, little research has been done to examine the association between allocated time for physical education, particularly physical education requirements, and students' academic achievement in high school contexts. It is not clear, thus, whether high school students can gain academic benefits from engaging in more physical education just as elementary students do. However, one study conducted by Nelson and Gordon-Larsen (2006) with high schoolers seems to suggest a potential positive relationship between physical education participation and student academic achievement. Nelson and Gordon-Larsen performed a cross-sectional study to examine the relations between physical activity (including physical education), sedentary behavior, health-risk behavior, and academic achievement using large-scale data from the National

Longitudinal Study of Adolescent Health (Add Health) of 11,957 7th-grade through 12th-grade students. Academic achievement was measured by self-reported grades in mathematics and science. Using a cluster analysis, the researchers identified seven clusters linked to physical activity and sedentary behavior. One of seven clusters (i.e., cluster 7) represented a group whose students had high participation in physical education programs, school sports, and school academic clubs. Results showed that students in the group of high engagement in physical education, school sports, and academic clubs were likely to have higher grades in mathematics and science than those in the group of low engagement. Additionally, students who participated in MVPA over five times per week were likely to have higher grades in mathematics and science than those who did not. Although Nelson and Gordon-Larsen's study may suggest that students who have more time in physical education are likely to have higher academic grades than those who do not, it should be cautiously interpreted because other factors such as participation in school sports and academic clubs were confounded with the effect of participation in physical education programs and students' prior academic achievement was not controlled in the analysis.

More recently, Ardoy, Fernández-Rodríguez, Jiménez-Pavón, Castillo, Ruiz, and Ortega (2013) examined the effects of the increased time and intensity of physical education on high school students' cognitive performance and academic achievement. Specifically, Ardoy and colleagues performed a group-randomized controlled trial from the EDUcation for FITness (EDUFIT) study of students (*N* = 67, ages 12–14 years) from one high school in Spain. Students were randomly assigned to the experimental group 2, experimental group 1, and control group. Students in the experimental group 2 and the experimental group 1 attended four physical education classes per week with and without high intensity, respectively, while those in the control group attended two physical education classes without intensity. Cognitive performance (e.g., verbal ability, non-verbal ability, verbal reasoning, abstract reasoning, spatial ability, numerical ability) and academic achievement (e.g., math, natural sciences) were determined by the Spanish Overall and Factorial Intelligence Test and by school grades, respectively. Results showed that students in the experimental group 2 had better cognitive performance (excluding verbal reasoning) and higher academic achievement (e.g., math) than those in both the experimental group 1 and the control group. No significant difference was found between students in the experimental group 1 and those in the control group. The researchers suggested, thus, that schools increase the frequency and intensity level of physical education to enhance cognitive functioning and academic achievement for high school adolescents.

All in all, there has been little research on the effect of physical education on or its relation to student academic achievement in secondary school settings. Because there are few studies from which to draw conclusions, it still remains unclear whether secondary students, particularly high schoolers, can obtain academic benefits from more physical education participation just like elementary students. It is also unclear whether academic benefits from engaging in more physical education differ by gender. Therefore, it is important to investigate the relationship between physical education and academic achievement with secondary students.

Physical Education and Academic Achievement by Gender

Although there has been gender-specific evidence in physical education and student academic achievement, relatively little research examined gender difference in the association between physical education and academic achievement. Among those few studies investigating the relationship by gender, a positive link has been shown between physical education and academic achievement among female students, but not among male students, in elementary school settings. For example, Carlson and colleagues (2008) found that female students (kindergarten–5th grade) who received high amount of physical education (70-300 min./week) had higher academic achievement in reading and mathematics than those with low amount of physical education (0-35 min./week) after controlling for students' socio-demographic backgrounds and prior academic achievement, whereas no such relation existed among male students. Similarly, Shephard (1996) demonstrated that female students (2nd grade–6th grade) experienced more academic benefits from attending physical education classes than male students. One possible reason for these relationships may be that female students are as physically active as or more active than male students during physical education even though female students are less active than male students during free play (e.g., Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998; McKenzie, Feldman, Woods, Romero, Dahlstrom, Stone, Strikmiller, Williston, & Harsha, 1995; Sarkin, McKenzie, & Sallis, 1997).

Although the findings of these studies suggest that female students may gain more academic benefits from participating in physical education than male students in elementary school, it is not clear whether such gender difference in the relationship can generalize to adolescent students in secondary school. The reason lies in the fact that physical activity level was lower among female adolescent students than among male adolescent students during physical education (e.g., Hannon & Ratliffe, 2005; McKenzie, Marshall, Sallis, & Conway, 2000). In Hannon and Ratliffe's (2005) study of high school students (N = 209), for instance, physical activity level was measured by pedometers and female students appeared to be less active than male students during physical education classes.

In addition, female students' participation in physical activity drastically declined during adolescence aged 9–18 years and the majority of female students did not participate in habitual physical activities outside school (Kimm et al., 2002). According to the results from the 2011 national school-based YRBS, the pervasiveness of not engaging in 60 minutes or more of physical activity on any day during seven days was higher among female (17.7%) students than among male (10%) students in high school (CDC, 2012; Eaton et al., 2012). Among adolescents aged 11–16 years between 2001 and 2009, female adolescents were less physically active and more frequently used computers for social networking, school assignments, and internet surfing than male adolescents (Iannotti & Wang, 2013b).

Taken together, female adolescents have a more sedentary lifestyle than male adolescents, not meeting a recommended level of MVPA (e.g., Lowry et al., 2009). Previous research has shown that female adolescent students are not likely to be physically active outside required physical education classes unlike male adolescent students. In this sense, physical education might be the only ideal place where female adolescent students regularly and actively engage in the recommended MVPA level. Therefore, engaging in physical activity during physical education classes might be more important for female adolescent students and have more impact on academic benefit than male adolescent students. Nevertheless, little research has been conducted on gender difference in the relationship between physical education and student academic achievement.

Summary of the Relationship between Physical Education and Academic Achievement

There is little evidence that schools' current policies and practices of reducing or eliminating physical education time or programs are effective in increasing students' standardized test scores, particularly in core academic subjects. Collectively, although a few studies have illustrated that engagement in physical education was negatively associated with students' academic achievement, many more studies have demonstrated that participation in physical education was positively related to, along with combined positive and non-significant links, students' classroom behaviors and academic achievement. In recent years, the accumulated reviews and empirical studies have increasingly provided evidence that adding time to physical education did not decrease, and in some or more cases, increased student academic achievement.

Given the current situation where schools have decreased or eliminated physical education time or programs to enhance students' academic achievement, more studies are needed to investigate whether schools' allocated time for physical education, particularly physical education requirements, is linked to students' academic achievement in high school settings. Altogether, schools' physical education requirement reduction or elimination to improve students' academic achievement should be determined by the evidence on the relationship between physical education time allocation and academic achievement.

Mechanism of the Relationship between Physical Education and Student Academic Achievement

As found in previous research, there has been increasingly consistent evidence that schools' allocated time for physical education might be positively associated with students' academic achievement. One possible reason for the positive relationship between physical education and student academic achievement lies mainly in that physical education provides regular physical activity, which may be linked to academic achievement. In this sense, the increased time in required physical education affords opportunities to engage students in more physical activity that could bring out academic benefit while not compromising academic achievement.

Given that the relation between physical education and academic performance is mainly due to *physical activity through* physical education, not physical education itself, the mechanism of the relationship between physical education and academic performance may also be explained by the results from previous studies which examined the association between physical activity through other school or non-school physical activity programs (e.g., sports, exercise, fitness) and academic performance. Therefore, this section describes the mechanism of the relationship between physical activity through both physical education and non-school physical education programs and academic performance.

Over the past years, the plausible mechanism to clarify this positive relationship including educational benefits of physical activity through physical education and other physical activity programs has been studied and discussed based mainly on the following benefits: (1) physical (fit and healthy), (2) affective (psychological or emotional), and (3) cognitive (academic) (e.g., Bailey, 2006; Bailey, Armour, Kirk, Jess, Pickup, Sandford, & BERA Physical Education and Sport Pedagogy Special Interest Group, 2009; Graber, 2001; NASPE, 2009a, 2009b, 2009c, 2009e; Penney, 2010; SHAPE America, 2014).

Physical Benefit of Physical Education and Academic Achievement

One plausible mechanism to explain a positive relationship between physical education and student academic achievement is that the increased physical activity through physical education enhances students' health and hence opportunities for their engagement in school or academic work and activity, leading to higher academic achievement (e.g., Tremblay et al., 2000). A large body of literature has consistently shown that physical education programs designed to increase physical activity improved students' health-related physical fitness such as body composition, cardiovascular endurance, and muscular strength and endurance (e.g., PCFSN, 2000; Sallis, McKenzie, Alcaraz, Kolody, Faucette, & Hovell, 1997) and promoted physical health while preventing or reducing health problems (e.g., McKenzie, Nader, Strikmiller, Yang, Stone, Perry, Taylor, Epping, Feldman, Luepker, & Kelder, 1996), which was known to have a positive link to academic performance (e.g., Castelli, Hillman, Buck, & Erwin, 2007; Chomitz et al., 2009; Sallis et al., 1999).

Specifically, it has been demonstrated that participating students in physical activity including physical education were likely to become more physically fit than their non-participating counterparts and, in turn, students' better status of physical fitness was related to their better cognitive performance (Hillman, Buck, Themanson, Pontifex, & Castelli, 2009; Hillman, Pontifex, Castelli, Khan, Raine, Scudder, Drollette, Moore, Wu, & Kamijo, 2014) and higher academic achievement (Castelli et al., 2007; Chomitz et al., 2009; Grissom, 2005). According to an empirical study of children (*N* = 38, ages 8–11 years), for instance, participants with low-level aerobic fitness based on the Progressive Aerobic Cardiovascular Endurance Run (PACER) test of the FITNESSGRAM showed poorer cognitive performance on the Eriksen flanker task than those with high-level aerobic fitness, implying less cognitive control, decreased attentional resource allocation, and increased conflict (Hillman et al., 2009). A more recent study of children (*N* = 48, mean age = 9.9 years) further illustrated that high-fit children had better cognitive functions in learning and memory than low-fit children during retention even though no significant difference was found during initial learning, indicating educational implications for policies and practices (Raine, Lee, Saliba, Chaddock-Heyman, Hillman, & Kramer, 2013). Chomitz, Slining, McGowan, Mitchell, Dawson, and Hacker (2009) also examined the association between physical fitness and academic achievement with a large sample of elementary and middle schoolers. Students' fitness level was assessed using the number of physical fitness tests passed during physical education classes. Academic achievement was assessed by the passing scores on the MCAS achievement tests in English (4th and 7th grades, *n* = 744) and mathematics (4th, 6th, and 8th grades, *n* = 1,103). Results showed a significant positive relation between the passing number and scores of physical fitness tests and the MCAS English and mathematics tests, respectively. The researchers concluded that physical fitness development by increasing physical activity opportunities through physical education was significantly associated with students' academic achievement. Similarly, Castelli, Hillman, Buck, and Erwin (2007) investigated the relation between physical fitness and academic achievement with 259 elementary students in 3rd and 5th grades. Field tests of physical fitness were positively related to students' academic achievement measured by standardized tests in reading and mathematics. Specifically, aerobic capacity was positively associated with academic achievement. More recently, Rauner, Walters, Avery, and Wanser (2013) supported this evidence that aerobically fit youth had higher academic achievement in standardized reading and mathematics tests than aerobically unfit youth, implying academic benefits from being physically fit.

In addition to physical fitness, previous studies have found that students' physical health such as chronic physical diseases negatively influenced their cognitive skills and academic achievement (e.g., Taras & Potts-Datema, 2005). For example, an empirical study of children (*N* = 74, ages 7–9 years) found that obese participants conducted poorer cognitive performance on a Go/NoGo task needing prefrontal inhibitory control than healthy weight participants (Kamijo, Pontifex, Khan, Raine, Scudder, Drollette, Evans, Castelli, & Hillman, 2012). Moreover, there has been some evidence that physical inactivity could cause serious health problems including obesity and particularly students who had health problems missed more school days than those who did not (e.g., Schwimmer, Burwinkle, & Varni, 2003). Other research has shown that BMI was used as one of the measures for obesity and appeared to be negatively associated with student academic achievement, indicating that overweight or obese students were likely to have lower academic achievement than their counterparts (e.g., Castelli et al., 2007; Chomitz et al., 2009). According to a more recent study of children (*N* = 126, ages 7–9 years), for instance, children with low BMI and fat mass showed better cognitive performance on a Go-NoGo task requiring inhibitory control and higher academic achievement on the Wide Range Achievement Test 3rd edition (WRAT3) including reading, spelling, and arithmetic than those with high BMI and fat mass (Kamijo, Khan, Pontifex, Scudder, Drollette, Raine, Evans, Castelli, & Hillman, 2012). However, another recent study of grades 4–8 students (*N* = 11, 743) from 47 public schools demonstrated that weight status measured by BMI percentile did not predict academic achievement in reading and mathematics upon the Nebraska State Accountability (NeSA) test scores (Rauner et al., 2013).

Given all these findings, some researchers have reasoned that participation in physical education enhances students' physical fitness and health which may lead to their higher school attendance and academic performance (e.g., Geier, Foster, Womble, McLaughlin, Borradaile, Nachmani, Sherman, Kumanyika, & Shults, 2007; Taras & Potts-Datema, 2005). Other researchers have suggested, thus, that schools promote students' physical fitness and health through physical education as well as classroom-based physical activity, school sports, and after-school physical activity to improve health habits, home and classroom behaviors, brain function or cognitive performance, and ultimately academic achievement (e.g., Davis & Cooper, 2011; Donnelly & Lambourne, 2011; Hillman et al., 2014; Mahar, Murphy, Rowe, Golden, Shields, & Raedeke, 2006; Pate, Heath, Dowda, & Trost, 1996; Rauner et al., 2013; Reilly, Buskist, & Gross, 2012; Raviv & Low, 1990; Siedentop, 2009).

Affective Benefit of Physical Education and Academic Achievement

Another possible explanation of a positive relationship between physical education and student academic achievement lies in the fact that the increased physical activity through physical education is associated with psychological or emotional well-being (e.g., Bailey, 2006) and self-belief including self-esteem (e.g., Trudeau & Shephard, 2008; Valentine, DuBois, & Cooper, 2004), which may have an impact on or a link to academic achievement (e.g., Aryana, 2010). There has been increased and consistent evidence that regular engagement in physical activity was positively related to students' psychological well-being. For example, some studies have shown that more physically active children were likely to have reduced anxiety, stress, and depression than less physically active children (e.g., Brosse, Sheets, Lett, & Blumenthal, 2002; Dunn, Trivedi, & O'Neal, 2001). Another cross-sectional study of Finnish adults (N = 3,403, ages 25–64 years) found that more frequent exercisers (i.e., 2–3 times/week) had lower levels of anger, stress, and depression than less frequent or no exercisers, implying a positive relation between regular physical exercise and psychological well-being (Hassmén et al., 2000). A more recent study of 779 adolescents aged 14–16 years demonstrated that participants in the healthy lifestyle promotion group including weekly 20-minute physical activity had better psychosocial and mental health (e.g., less depression) and higher academic achievement than those in the control group excluding physical activity (Melnyk, Jacobson, Kelly, Belyea, Shaibi, Small, O'Haver, & Marsiglia, 2013). Because children and adolescents can regularly engage in physical activity during required physical education classes, it seems that increased physical activity through physical education may be positively linked to psychological or emotional well-being.

The evidence has been especially apparent in self-esteem as one of the important self-beliefs and a key component of mental well-being or health, which can be promoted through physical activity including physical education or exercise (e.g., Fox, 2000; Valentine et al., 2004). Self-esteem is a term used to reflect one's assessable or evaluative judgment of himself or herself, which is focused on global feelings of self-worth and hence similar but different from self-concept, as a descriptive element of or being affectively (i.e., emotional self-attitude) predicted by self-concept (Bong & Skaalvik, 2003; Harter, 1983; Rosenberg, 1979; Scheirer & Kraut, 1979). Because this construct emerges when children compare their self-evaluation with actual performance on a variety of tasks (Mohammad, 2010), physical education may be an important school curricular subject and environment where teachers can promote the development of students' self-esteem (Hein & Hagger, 2007).

In this regard, previous researchers have reported a strong relation between physical education participation and students' self-esteem (Coe et al., 2006; Hein & Hagger, 2007; Nelson & Gordon-Larsen, 2006; Shephard, 1996; Tremblay et al., 2000; Yu, Chan, Cheng, Sung, & Hau, 2006). For example, Nelson and Gordon-Larsen (2006) found a significant positive link of school-based physical activities (i.e., physical education, sports team) to self-esteem and academic achievement (i.e., math, science) among secondary students (N = 11,957, grades 7–12). Specifically and notably, physically active adolescents who achieved five or more bouts per week of MVPA tended to have less risk of low self-esteem and higher academic grades in mathematics and science than their physically inactive counterparts, with little gender difference in self-esteem. An analysis of Hong Kong preadolescents also showed that high level of school physical activity was associated with high self-esteem (Yu et al., 2006).

One interesting result from Yu and colleagues' (2006) study was a positive link between physical activity level and self-esteem found among male students only, which was inconsistent with that of Nelson and Gordon-Larsen's study (2006). One possible reason for the gender difference in the psychological effect of physical education explained by Yu and colleagues is that level of physical activity does not vary among female students and hence remains low as compared to male students, implying no relation between physical activity level and self-esteem. Tremblay, Inman, and Willms (2000) conducted another interesting study to investigate the relation between physical activity level and self-esteem with 6th-grade students (N = 6,923) in Canada. The level of physical activity had a positive association with students' self-esteem. Unlike Yu and colleagues' study, Tremblay and colleagues' study demonstrated that both male and female students who were more physically active had higher self-esteem than their counterparts even though female students had significantly lower levels of physical activity and self-esteem than male students. The significant difference in self-esteem level between male and female students disappeared after adjusting for physical activity level. These findings indicate that the effects or benefits of more participation in physical activity (including physical education) on self-esteem may be greater among girls than among boys and hence help close the gender gap (e.g., Kling, Hyde, Showers, & Buswell, 1999).

Given that physical education provides all school-age students with physical activity as required in the school curriculum, physical activity through physical education might contribute to improving children and adolescents' psychological or emotional well-being and self-esteem (e.g., Shephard, 1997). Although the mechanism of this relation is unclear, researchers have claimed that school-age youth wish to be seen as competent in physical activity and thus achievement in the physical domain may have a strong causal link to self-esteem (e.g., Rosenberg, Schooler, Schoenbach, & Rosenberg, 1995; Shephard, 1996). Notably, Whitehead and Corbin (1997) argued that participating in physical education can positively influence physical self-esteem and facilitate the most desirable forms of motivation only when physical activity is properly employed. Conversely, inappropriately used physical education programs can have a negative effect on students' motivation and self-esteem. It indicates that providing students with relevant and appropriate physical activities during physical education is necessary to enhance their self-esteem which may be partly or more associated with academic achievement.

Cognitive Benefit of Physical Education and Academic Achievement

The last and most important mechanism to explain a positive relationship between physical education and student academic achievement is that the increased physical activity through physical education helps the brain function efficiently and improves its cognitive skills or functioning for learning (Chaddock et al., 2011; Summerford, 2001; Taras, 2005; Taylor & Lamoreaux, 2008; Tomporowski et al., 2008). In other words, lack of physical activity (e.g., aerobic exercise) among children has a negative impact on or relation to cognitive health and academic performance as well as physical and mental health (Donnelly & Lambourne, 2011; Hillman, Erickson, & Kramer, 2008; Raine et al., 2013). Physical activity is also important to adolescents in that adolescence is a critical transition from childhood to adulthood and a final stage of extensive (neuro)biological changes, particularly brain growth and maturation until young adulthood, which may positively influence or be linked to cognitive or intellectual development and academic achievement as well as behavioral and affective development (Blakemore & Choudhury, 2006; Paus, 2005; Steinberg, 2005; Yurgelun-Todd, 2007).

In neurocognitive science research, physical activity has been seen as a vital aspect of the brain's ability to cognitively function such as attention, memory, information processing, inhibition, and cognitive flexibility (e.g., Hillman et al., 2014; IOM, 2013a; Kohl & Cook, 2013). Specifically, physical activity influences the brain's physiology by increasing cerebral capillary growth, blood flow, oxygenation, growth of nerve cells in the hippocampus (center of learning and memory), neurotransmitter level, development of nerve connection, density of neural network, and brain tissue volume (Jensen, 1998, 2005; Shephard, 1997), which are closely related to cognitive functioning (Tomporowski et al., 2008). As an illustration, Sibley and Ethnier (2003) analyzed the effect of physical training on cognitive functioning using a meta-analysis of more than 40 studies. A significant positive relation was found between physical activity and cognitive functions such as perceptual skills, IQ, concentration, memory, performance, and academic readiness, which were closely associated with academic achievement. These neurocognitive science studies have proposed that similar to adults, physical activity or exercise for children and adolescents promoted brain or mental functioning central to cognitive development, thus contributing to academic performance (Caterino & Polak, 1999; Colcombe, Kramer, Erickson, Scalf, McAuley, Cohen, Webb, Jerome, Marquez, Elavsky, & Greenough, 2004; Hillman, Castelli, & Buck, 2005; Hillman et al., 2014; Sibley & Etnier, 2003; Tomporowski et al., 2008).

In this regard, there has been evidence that the increased physical activity enhanced cognitive functioning for children through adults. For example, Hillman, Castelli, and Buck (2005) examined the relation between physical fitness level and cognitive functioning with 24 children (mean age = 9.6 years) and 27 young adults (mean age = 19.3 years). The level of physical fitness was positively related to neuroelectric indices of attention and working memory for all participants. Also, children participants' physical fitness status was associated with cognitive processing speed, indicating that physically fit students were likely to pay more attention to academic activity and to work more efficiently than physically unfit students. Similarly, Colcombe and colleagues (2004) found that the increased cardiovascular fitness in older adults (ages 58–77 years) improved the functioning of key aspects of the brain's attentional network during a cognitively challenging task.

Another relevant and interesting study of 13 male adults (mean age = 31.9 years) was performed by Maguire, Frith, and Morris (1999) who investigated brain activation related to reading comprehensive task. General memory processing and retrieval functions during reading comprehension were linked to an activation of the prefrontal cortex and posterior parietal cortex, which was also involved when highly fit or aerobically trained participants showed greater activities than low-fit or non-aerobic control participants. More recently and notably, Ardoy and colleagues (2013) conducted randomized controlled intervention research of 67 Spanish high schoolers aged 12–14 yeas. Participants in the experimental group 2 (4 × 55-min. PE sessions/week with high intensity) cognitively and academically outperformed those in both the experimental group 1 (4 × 55-min. PE sessions/week without intensity) and the control group (2 × 55-min. PE sessions/week without intensity).

In addition, there has been increasing evidence that physical activity (including aerobic or cardiovascular exercise) promoted executive functions for children through adults, which have been relatively recently studied and regarded as multidimensional and interrelated cognitive or (neuro)psychological processes necessary and important particularly for effortful and goal-directed control or regulation over cognition/thought and behavior/action (Agostino, Johnson, & Pascual-Leone, 2010; Best, 2010; Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008; Davis, Tomporowski, Boyle, Waller, Miller, Naglieri, & Gregoski, 2007; Davis, Tomporowski, McDowell, Austin, Miller, Yanasak, Allison, & Naglieri, 2011; Diamond, 2012; Diamond & Lee, 2011; Hillman et al., 2014; Hillman, Snook, & Jerome, 2003; Riggs, Blair, & Greenberg, 2003; Tam, 2013; Waber, Gerber, Turcios, Wagner, & Forbes, 2006). Executive functions have been found to be crucial for school readiness (e.g., cognitive competency, socioemotional/social-emotional skill) and success (e.g., classroom behavior) serving as a good moderator or mediator and predictor of student cognitive (e.g., self-regulation) and academic (e.g., high-stakes standardized test) performance, which mainly include inhibition (e.g., self-control), cognitive flexibility (e.g., shifting/switching), and working memory (also often called updating) (Agostino et al., 2010; Anderson, 2002; Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001; Best, 2010; Best, Miller, & Naglieri, 2011; Bierman et al., 2008; Blair & Diamond, 2008; Blair & Razza, 2007; Bull, Espy, & Wiebe, 2008; Bull & Scerif, 2001; Diamond, 2012; Diamond & Lee, 2011; Hillman et al., 2014; Lan, Legare, Ponitz, Li, & Morrison, 2011; Lehto, Juujarvi, Kooistra, & Pulkkinen, 2003; Monette, Bigras, & Guay, 2011; Riggs et al., 2003; St Clair-Thompson & Gathercole, 2006; Waber et al., 2006). Specifically, executive functions provided preschoolers through adolescents (ages 3–17 years) with fundamental academic abilities such as reading comprehension and writing skills, mathematical reasoning and problem solving, and scientific thinking and reasoning in core subjects (i.e., reading/English, math, science), implying a positive relation between executive functions and academic achievement.

To illustrate, St Clair-Thompson and Gathercole (2006) examined the relations between executive functions (i.e., shifting, updating, inhibition) and working memory (i.e., verbal, visuo-spatial), and student scholastic attainment measured by standardized tests (i.e., English, math, science) with children (*N* = 51, ages 11–12 years) in England. Among executive functions, inhibition was significantly related to children's scholastic attainment in English (e.g., reading, writing), mathematics (e.g., arithmetic), and science, but working memory was significantly associated with academic achievement in English and mathematics only. More specifically, visuo-spatial working memory was significantly associated with English, mathematics, and science attainment, whereas verbal working memory was significantly linked to English achievement only. Interestingly enough, these results indicate a domain-specific relationship between executive functions and working memory, and scholastic attainment. More recently, Best, Miller, and Naglieri (2011) investigated the association between executive function (i.e., planning) and student academic achievement measured by Woodcock–Johnson Tests of Achievement-Revised (WJ-R) (i.e., reading, math) with children and adolescents (*N* = 1,395, ages 5–17 years) sub-sampled from a nationally representative sample of U.S. elementary and secondary students. Unlike St Clair-Thompson and Gathercole's study, Best and colleagues' study demonstrated a domain-general association between executive function and academic achievement in overall reading and overall mathematics. Notably, the researchers also found that an intra-domain variability existed within mathematics, illustrating a stronger significant correlation between executive function and applied problems than calculation.

In sum, these neurocognitive science studies have proposed that engagement in physical activity (including physical education or exercise) might facilitate a neurotic network or function in the brain and enhance cognitive development affecting or relating to academic performance. Further, through this neuroscientific view, promoting participation in physical education at school increases the amount and level of physical activity which may help improve student academic achievement.

Other Individual and Social Environmental Factors on Student Academic Achievement

Academic achievement in reading, mathematics, and science is crucial for academic/educational and career success for high school students because it is key to general and Science, Technology, Engineering, and Mathematics (STEM) education, and thus the results and benefits of academic achievement in these core subjects are closely related to or extensively affect their college admission and future job or employment (e.g., Engberg & Wolniak, 2010; Hearn, 1991; Perna & Titus, 2005; Wang, 2013). Given the importance of high school experience and accomplishment, educational researchers and practitioners have sought to investigate various factors which might explain students' academic achievement (e.g., standardized test score, grade) in secondary school (e.g., Marsh & Kleitman, 2002). The findings of previous studies have revealed that the factors influencing or relating to academic achievement in those core subjects for high schoolers appeared to be complex, which included individual and social environmental factors as well as academic and non-academic factors. In order to better understand the relationship between a school's physical education requirements and students' academic achievement, those potential factors that may directly or indirectly affect or be linked to academic achievement should be carefully considered and rigorously controlled. Particularly, those possibly influential or relevant factors can be divided into three broad and main categories: student personal characteristics, family environment, and school environment.

Student Personal Characteristics and Academic Achievement

Previous research has indicated that key influences on academic achievement are students' academic backgrounds (including cognitive ability) and motivation as well as their own socio-demographics and other social environments (e.g., Abu-Hilal, 2000; Lyon, 1993; Mosqueda, 2010; O'Conner & Miranda, 2002). The most influential or relevant individual factors include: students' socio-demographic backgrounds such as gender and minority status or race/ethnicity; students' health background such as health status including illness or disability; students' motivational backgrounds such as academic self-concept and academic aspiration; and students' academic backgrounds such as school program placement, prior academic achievement or initial cognitive ability, and coursetaking such as total units earned and course level taken. In addition to those factors, students' sports backgrounds such as school sports participation and non-school sports participation have been found to be linked to their academic achievement. Therefore, this study included students' school and non-school sponsored sports participation to avoid its confounding effect with physical education on academic achievement.

Previous research has demonstrated that students' academic achievement differed by gender. For example, some studies have shown that female students outperformed male students in reading, whereas male students performed better than female students in mathematics and science (e.g., Eitle, 2005; Tremblay et al., 2000). Interestingly, other studies have suggested that school-age girls might academically benefit more from participating in physical education than school-age boys (e.g., Carlson et al., 2008; Shephard, 1996). In Shephard's (1996) study, for instance, elementary students in the intervention group who spent 13% to 14% more time in physical education classes outperformed those in the control group on academic report cards. Specifically, girls academically gained more from taking extra exercises than boys. A more recent study by Carlson and colleagues (2008) found significant academic benefits in reading and mathematics among girls enrolled in high amount of elementary physical education, but not among boys. These findings indicate that academic benefits from more participation in physical education may be greater among girls than among boys in elementary school settings. Little is yet known about gender difference in the academic benefit of physical education engagement between male and female adolescent students in secondary school contexts, particularly the link of physical education requirements to academic achievement in high school.

Students' minority status or race/ethnicity has been reported to be another major factor explaining the difference in academic achievement. Numerous studies have found White and Asian students to be at an advantage and to have higher academic achievement than Black and Hispanic students in secondary school (e.g., Peng & Wright, 1994; Ripski & Gregory, 2009). Also, previous research has consistently illustrated that there was a racial/ethnic difference in physical education participation and physical activity level. In general, the prevalence rate of physical activity appeared to be low particularly among minority children and adolescents (Andersen et al., 1998; CDC, 2006, 2012; Eaton, Kann, Kinchen, Ross, Hawkins, Harris, Lowry, McManus, Chyen, Shanklin, Lim, Grunbaum, & Wechsler, 2006a, 2006b; Gordon-Larsen, McMurray, & Popkin, 1999, 2000; Kimm et al., 2002). Specifically, the 1996 Add Health reported that there was no significant racial/ ethnic difference of engaging in the highest category of MVPA. However, among female students, non-Hispanic Whites and Asians participated in the highest category of MVPA more than non-Hispanic Blacks and Hispanics (Gordon-Larsen et al., 1999, 2000). In contrast, the results of the 2005 and 2011 national school-based YRBS showed that both White male and female students participated in at least 60 minutes per day on five or more days per week more than both Black and Hispanic male and female students (CDC, 2006, 2012; Eaton et al., 2006a, 2006b, 2012). Moreover, the decreased rate of physical activity participation during adolescence was greater among minority students than among White students. For example, the prevalence of not engaging in at least 60 minutes of physical activity on any weekday or weekend was higher among Black (19.6%) and Hispanic (15.9%) students than among White (11%) students (CDC, 2012; Eaton et al., 2012). Another study by Gordon-Larsen, McMurray, and Popkin (2000) supported this evidence that overall physical activity was lower among non-Hispanic Black and Hispanic adolescents than among non-Hispanic White and Asian adolescents. Specifically and notably, engagement in physical education appeared to be lower among non-Hispanic Black and Hispanic adolescents than among their peers while decreasing from ages of 12 (high) through 17 (low) years.

Previous studies have also shown a significant association between students' health status and their academic achievement. Using data from the nationally representative kindergarteners (ECLS-K), for instance, Crosnoe (2006) found that children in poor physical health were likely to have lower academic motivation and lower academic achievement in mathematics than those in good physical health. Researchers believe that health problems during childhood influence academic performance because children in poor health (1) are less school ready, (2) have more missed school days, and (3) can learn or perform less in and out of school than those in good health (e.g., Case & Paxson, 2006).

While there are a number of socio-demographic and other factors affecting or linking to student academic performance, previous research has proposed that students' motivational factors such as academic self-concept and academic aspiration were related to academic achievement. For example, general self-concept, which can be broadly defined as one's general or global perception of himself or herself in given areas (e.g., Shavelson & Bolus, 1982; Shavelson, Hubner, & Stanton, 1976), has been found to have a positive association with academic performance and vice versa including a stable structure in measurement (e.g., Huang, 2011; Wang & Su, 2013). Besides or beyond the general self-concept, academic self-concept, which is one specific facet of self-concept and referred to as a person's perceived view of himself or herself as a learner particularly in academic fields (e.g., Bong & Skaalvik, 2003; Byrne, 1984; Kurtz-Costes & Schneider, 1994), has been reported to be closely related to or strongly predictive of academic achievement. Both general and academic self-concepts have been commonly characterized as domain-specific, multidimensional, and gender differentiated even though academic self-concept served as a better predictor of student or school academic performance than general or other self-concepts including global self-esteem (e.g., Byrne, 1986; Marsh, 1990; Muijs, 1997; Wilgenbusch & Merrell, 1999). In Lyon's (1993) study, for instance, middle school students' (N = 88, grades 7–8) academic self-concept appeared to be more strongly linked to their academic achievement than general self-concept and classroom behaviors while also being more predictive of academic achievement than locus of control.

Furthermore, academic aspiration, which can be defined as one's subjective desire and intention to pursue his/her academic goals in formal education (e.g., Bentler & Speckart, 1979; Cobb, McIntire, & Pratt, 1989; MacBrayne, 1987; Quaglia & Cobb, 1996), has been found to be multidimensional and an important contributor to academic performance and effective schooling (e.g., Quaglia, 1989). To illustrate, Brookover, Erickson, and Joiner (1967) found that high school students' academic aspirations were significantly related to their GPAs in English, mathematics, science, and social studies. More recently, Abu-Hilal (2000) investigated the causal relations between attitudes toward school subjects (i.e., English, math, science, social studies), academic aspirations, and academic achievement measured by the Stanford Test of Academic Skills and Tasks (i.e., reading, English, math) with high school students (N = 280, grades 9–12). There was a significant direct effect of students' academic aspirations on their academic achievement. Another recent study by Liu, Cheng, Chen, and Wu (2009) examined the association between secondary students' (N = 2,000) academic aspirations and their academic achievement measured by the General Analyzing Ability Test in Taiwan. Students who had high academic aspirations displayed higher academic achievement growth than those who had low academic aspirations.

Aside from motivational backgrounds, previous research has demonstrated that secondary students' academic backgrounds were crucial for their academic achievement.

Among them, for instance, students' prior academic achievement or abilities appeared to be one of the most important factors on or predictors of their academic achievement in high school (O'Conner & Miranda, 2002). Using large-scale assessment data from the National Education Longitudinal Study of 1988 (NELS:88), the Education Longitudinal Study of 2002 (ELS:2002), and the High School Longitudinal Study of 2009 (HSLS:2009), numerous studies have also attempted to examine the relationship between adolescents' prior academic achievement or cognitive abilities and their academic performance in secondary school. For example, it has been consistently reported that high school students' prior or initial academic achievement or abilities measured by prior test scores were the most influential factor or the strongest predictor related to their academic performance in mathematics and science (e.g., Elliott, 1998; Mussoline & Shouse, 2001; O'Conner & Miranda, 2002; Pong, 1998). These findings were similar to those found in previous school effects studies of elementary students (e.g., Lee, Burkam, Ready, Honigman, & Meisels, 2006).

In addition, students' coursetaking such as the number or unit of courses earned and level of courses taken has been found to be another important factor on their academic achievement in high school. Some studies have shown that 10th-grade students who took more and higher levels of mathematics courses during high school years obtained considerably higher academic achievement in mathematics than those who took fewer and lower levels of mathematics courses after controlling for students' prior mathematics achievement (e.g., Rowan, Chiang, & Miller, 1997). However, other studies with high school students have found no association between these two variables in both mathematics and science after controlling for students' prior academic achievement (e.g., Lee, Smith, & Croninger, 1997). Moreover, students' school program or track placement in high school (e.g., academic, non-academic) was related to their academic achievement (Gamoran, 1992; Mosqueda, 2010; Rowan et al., 1997). Mosqueda (2010) demonstrated, for instance, that high school students in an academic track had higher academic achievement in mathematics than those in a general or vocational/technical track.

Given the findings of previous studies on the positive or neutral relation between school physical education and student academic achievement, it is also important to consider students' participation in school and non-school sports programs. Similar to academic benefits from engaging in physical education, participating in school and non-school sports offers chances for students to be physically active and healthy which may affect or be linked to their academic achievement as well as collegiate or occupational attainment and life skills development (e.g., Barber, Eccles, & Stone, 2001; Danish, Forneris, & Wallace, 2005; Holt, Tink, Mandigo, & Fox, 2008). Additionally, students' engagement in varsity sports teams during adolescence appears to be one of the most influential factors on their physical activity level during adulthood along with less physician visit (e.g., Dohle & Wansink, 2013). In considering the association between interscholastic sports participation and student academic achievement, previous studies have reported mixed findings. For example, Daley and Ryan (2000) examined the relation between frequency and duration of sports participation and academic achievement measured by English, mathematics, and science tests with secondary students (N = 232, grades 8–11). Overall, there was no significant association between the amount of time spent in sports activity and scores (i.e., grades) in English, mathematics, and science for all students. It is noteworthy, however, that there were some weak and negative relations among adolescents aged 13, 14, and 16 years in English and among those aged 16 years in science, respectively, implying age-specific debilitation. In contrast, Stephens and Schaben's (2002) study of middle schoolers demonstrated that participating students in interscholastic sports had significantly higher mathematics grades, mathematics standardized test scores, and GPA than non-participating students. The researchers also found that as interscholastic sports participation increased, mathematics standardized scores and GPA improved among both male and female students. Similarly, the results from a nationally representative longitudinal study of high schoolers showed that participation in interscholastic sports had positive relations to school grades (i.e., English GPA, math GPA) and standardized test scores (i.e., reading, math) (Broh, 2002). Of interest is that intramural sports participation appeared to provide students with less or no academic benefits as compared to interscholastic sports participation. Specifically, participating students in intramural sports had lower academic achievement scores in reading and mathematics than their non-participating counterparts.

It is not clear why there are mixed or inconsistent findings on the association between school sports participation and student academic achievement. In reaction to this, researchers have reasoned that engagement in school athletic teams enhances students' social and emotional development and ties among peers, teachers, parents, and schools, thus leading to their improved academic achievement (e.g., Broh, 2002). Another study by Hunt (2005) pointed out that students who got better grades might be likely to participate in more extracurricular activities including school sports.

In addition, it is interesting to note that students' participation in interscholastic sports teams was found to be associated with their socio-demographic factors such as gender, parents' educational level, and SES. Specifically, male students were more likely to participate in interscholastic sports teams than female students (e.g., Colabianchi, Johnston, & O'Malley, 2012; Darling, 2005; Drake, Longacre, MacKenzie, Titus, Beach, Rundle, & Dalton, 2014). Also, students whose parents had high educational level and high SES were more likely to engage in interscholastic sports teams than their counterparts (Drake et al., 2014). This may be partly because participation in school athletic teams and programs require students to invest extra or more time and activity fee for their participation, gear, travel, and so forth (Lee et al., 2007). Therefore, it seems reasonable that low-income family students are less likely to participate in extracurricular or after-school physical activities or sports and extended play due to high cost and safety (Thomas, 2004). Another interesting finding was that students' participation rate in interscholastic sports was related to schools' socioeconomic factors. Colabianchi, Johnston, and O'Malley (2012) found, for instance, that students' participation in interscholastic sports increased as schools' socioeconomic composition and facilities increased. Given this, it is cautiously concluded that simply encouraging participation in school sports may not be the answer to promote physical activity or health and academic performance for all children and adolescents.

Family Environment and Academic Achievement

It has been widely acknowledged that students' academic achievement varied depending on family environment as well as their personal characteristics and school environment (e.g., Ham, 2003; Rouse & Barrow, 2006; Singh, Bickley, Trivette, Keith, Keith, & Anderson, 1995). Previous research has demonstrated that student academic achievement was closely associated with the following family environmental factors:

family's socio-demographic backgrounds such as family socioeconomic status (SES) and family structure; and parents' involvement such as parental participation, parental discussion, and parental expectation. Among them, one important family environmental factor on student academic achievement has been found to be family SES. The family SES measure is often determined by parents' educational level, income, and occupation, which has been well known to explain students' academic achievement (e.g., Toutkoushian & Curtis, 2005). Students with high family SES generally tended to outperform those with low family SES in academic achievement. Martin, Meyer, Nelson, Baldwin, Ting, and Sterling (2007) found, for instance, that family income was positively linked to children's (*N* = 138, ages 4–8 years) mathematics scores measured by the Comprehensive Mathematics Inventory, indicating that family income was a stronger predictor of mathematics achievement than self-control and locus of control. Rouse and Barrow (2006) also reported that adolescents from families in the highest SES quartile had higher average test scores than those from families in the lowest SES quartile. Similarly, Kim and colleagues (2003) demonstrated that higher parental education level was significantly related to higher GPA for 5th- and 8th-grade students (Kim, Frongillo, Han, Oh, Kim, Jang, Won, Lee, & Kim, 2003). Of interest is that students with high socioeconomic background not only performed better in their academic achievement, but also more frequently participated in physical activity (including physical education) than those with low socioeconomic background. For example, Darling, Caldwell, and Smith (2005) found that parents' educational experiences were strongly associated with their children's participation in physical activity and academic achievement. Adolescents whose parents had low educational level were markedly less likely to engage in physical activity than their peers whose parents had high educational level.

Previous research has also shown that family structure played a critical role in student academic performance while being characterized as complex and dynamic. Notably enough, family structure appeared to be one of the best predictors of student academic achievement particularly in secondary school (e.g., O'Conner & Miranda, 2002). In general, there has been evidence that single-parent families due to parental divorce or separation, parental death, and other reasons had negative impacts on or relations to secondary students' school or classroom behaviors (e.g., skipping school) and academic achievement (e.g., Walberg & Greenberg, 1996). For example, Ham (2003) compared GPA and school attendance between students from divorced single-parent families and those from intact families with 1,150 high school seniors. Students from intact families outperformed those from divorced single-parent families in both school attendance and GPA. Interestingly, female students were more negatively affected by parents' divorce than male students, which was consistent with Sun and Li's (2009) recent study. Given the small sample size, however, Ham could not examine the effect of single-parent families caused by parental death on student academic achievement.

Pong and Ju (2000) also investigated the association between family structure and secondary school dropout rate using the NELS:88 data. Middle and high school dropout rates were significantly higher among students from divorced single-parent families than among those from intact families. When reduced family income resulting from parents' divorce was considered, however, this result was no longer significant, implying a spurious relation between family structure by parental divorce and student academic performance. The results of Pong and Ju's study supported the explanation by McLanahan (1985) that the relation was due to a financial disadvantage from family structure caused by parents' divorce or death. Given the decreased household income for children's education in single-parent families, consequently, students who experienced parents' divorce or death were likely to have lower academic performance than those from intact families.

In addition, previous studies have found that parental school involvement such as volunteering, participation in academic work or school activities, discussion with a child, communication with or relationship to a teacher or school administrator, and expectation for a child's education were consistently related to student academic achievement (e.g., Fan, 2001; Hill, Castellino, Lansford, Nowlin, Dodge, Bates, & Pettit, 2004; Hill & Taylor, 2004; Jeynes, 2003; Seyfried & Chung, 2002; Stewart, 2008). In general, students whose parents were more involved in their children's academic work and school activities or events (also called "academic socialization") enhanced academic motivation or engagement, school or classroom behaviors, academic or career aspirations, and academic achievement more or higher than those with less involved parents, thus leading to educational benefits (Comer & Haynes, 1991; Gonzalez-DeHass, Willems, & Holbein, 2005; Hill, Ramirez, & Dumka, 2003; Hill & Tyson, 2009, p. 742). However, previous research on parental home involvement such as monitoring or supervision of a child's motivation or engagement, reading with or for a child, discussion with a child, going out with a child, and providing supportive learning environment has shown an inconsistent relation to student academic achievement (e.g., Barnard, 2004; McWayne, Hampton, Fantuzzo, Cohen, & Sekino, 2004).

It is also noteworthy that the association between parental involvement and student academic engagement or achievement varied across different kinds or measures of parent involvement, implying multidimensional characteristics and mixed results (Fan, 2001; Gonzalez-DeHass et al., 2005; Lee & Bowen, 2006; Pong, 1997; Sui-Chu & Willms, 1996). Among various types, dimensions, or predictors of parent involvement, parental expectation for a child's education was found to have a major effect on or even the strongest positive link to student academic achievement (Fan, 2001; Feuerstein, 2000; Holloway, Yamamoto, Suzuki, & Mindnich, 2008; Seginer & Vermulst, 2002). For example, Singh, Bickley, Trivette, Keith, Keith, and Anderson (1995) examined the impact of four different components of parent involvement (i.e., parental education expectation for children, parental engagement in school activities, parent-child communication about school, home structure) on 8th-grade students' academic achievement. Parents' expectations for children's education had the strongest positive association with students' academic achievement among four components of parent involvement and other family environments (e.g., family SES).

Similarly, Fan and Chen (2001) demonstrated the most significant and strongest positive relation between parents' expectations for children's educational attainment and students' academic achievement using a meta-analysis of more than 40 studies. Also, this relation was stronger in GPA than subject-specific test scores (i.e., reading, math). Using longitudinal data (e.g., NELS:88, ELS:2002, HSLS:2009), other recent studies with secondary students have illustrated the consistent and positive links between parents' educational expectations for children and students' academic achievement measured by subject-specific test scores (i.e., reading, math, science, social sciences) and GPA (e.g., Fan, 2001; Flowers & Flowers, 2008; Seyfried & Chung, 2002).

School Environment and Academic Achievement

Previous school effects studies about the school's environmental impact on or relation to students' academic achievement have sought to examine the association between various school environmental factors and student academic achievement (e.g., Konstantopoulos, 2006; Lee & Burkam, 2003; Sellström & Bremberg, 2006). The school effects studies generally aimed to investigate how school environment can be effectively used to improve student academic achievement. Many school effects studies have demonstrated that academic achievement varied depending on school environmental factors as well as student individual and family environmental factors. It has been reported that student academic achievement was closely related to the following school environmental factors: schools' socio-demographic backgrounds such as school type or sector, school size or entire enrollment, school urbanicity, school socioeconomic status (SES) or composition, minority student concentration, and single-parent student concentration; and schools' academic background such as school academic composition. Particularly, this study included schools' sports climate such as school emphasis on sports, which is one of the school climate characteristics to avoid its confounding effect with physical education on student academic achievement.

Among the school's environmental factors, school type has been found to be one important factor on student academic achievement to be considered. However, the results of the association between school type and academic achievement remained inconclusive. In some studies, for instance, students who attended private schools were likely to have higher academic achievement than those in public schools (e.g., Carolan, 2010; Mosqueda, 2010), but in other studies, students attending public schools were not significantly different in academic achievement from those in non-public schools (e.g., Haghighat, 2005; Pong, 1997, 1998).

Previous studies have also illustrated that there was an impact of school size on or its link to student academic achievement even though the results on an appropriate or optimal school size were inconclusive. Lee and Smith (1997) demonstrated, for instance, that academic achievement for high schoolers was higher in medium-size schools with the enrollment of 601-900 students than in schools with small (especially less than 300) and large (particularly more than 2,100) enrollment sizes. Inconsistent with Lee and Smith's study, Werblow and Duesbery's (2009) study recently found that students who attended very small-size (< 674) or very large-size (> 2,592) schools had greater gains in mathematics than those in moderate-size schools, implying the non-linear relation between high school size and mathematics achievement growth. Another study by Ripski and Gregory (2009) showed that as school size increased, high school students' academic achievement increased in both reading and mathematics.

School urbanicity has been found to be another influential factor on student academic achievement even though previous research has reported mixed results on the association between school urbanicity and academic achievement. To illustrate, some research has shown that students who lived in rural areas were likely to have higher academic achievement in reading and mathematics than those in suburban areas after adjusting for other school environmental factors such as school size and school SES (e.g., Pong, 1998). Other research has found, however, that students who lived in urban areas tended to have higher mathematics achievement growth than those in rural and suburban areas (e.g., Sellström & Bremberg, 2006; Webster & Fisher, 2000; Werblow & Duesbery, 2009; Young, 1998).

Furthermore, school SES has been found to be one of the most influential factors on student academic achievement. The school SES has been often measured by aggregating students' family SES into the school level (e.g., Lee & Burkam, 2003; Lee & Smith, 1997; Ma, Ma, & Bradley, 2008) and hence represented the impact of school SES over and above family SES on student academic achievement. In general, previous research has consistently reported that students who attended schools with high SES were likely to have higher academic achievement than those attending schools with low SES over and beyond their family SES (Haghighat, 2005; Ripski & Gregory, 2009; Rumberger & Palardy, 2005). One plausible explanation on this positive relation is that just as schools in high SES neighborhoods tend to have more resources than those in low SES neighborhoods, teachers in high SES schools are often more or better trained than those in low SES schools.

In addition to school SES, school effects research has demonstrated that concentration of minority students and concentration of single-parent students in schools were related to students' academic achievement, respectively, after controlling for student socio-demographics and family background. For example, the percentage of 8th-grade minority students was negatively associated with test scores in reading and mathematics in middle school (Haghighat, 2005). One interesting result from Haghighat's (2005) study was that this negative relation was no longer significant when school SES was controlled. Similarly, there was evidence that schools with a high percentage of students from single-parent families had significantly lower academic performance in 10th-grade reading and mathematics than those with a high percentage of students from two-parent families (Pong, 1998). This relation did not disappear even after controlling for student socio-demographics (e.g., gender, race/ethnicity) and family background (e.g., family SES, family structure).

School academic composition has been also found to be one of the school environmental factors affecting or linking to student academic achievement. School academic composition represents one of the school's academic climates and was often measured by averaging students' academic achievement (i.e., test score, GPA). For example, Rowan, Chiang, and Miller (1997) created school academic composition variable by averaging students' academic achievement in reading, science, and social studies. Results showed that school academic composition was strongly linked to students' mathematics achievement in high school after controlling for other student- and school-level variables. Lee and Burkam (2003) also found that school academic composition was associated with high schoolers' drop-out rate. Specifically, schools with high academic composition showed students' lower drop-out rate than those with low academic composition after adjusting for other student- and school-level factors. Another study by Lee and Smith (1996) found that school academic composition was associated with student academic achievement particularly where teachers' willingness to take responsibility for student learning was high.

When compared to other school environmental factors, there has been little research on the effect of schools' sports climate or policy on or its link to students' physical activity and particularly academic achievement in secondary school along with one of the few studies, which was conducted by Bocarro, Kanters, Cerin, Floyd, Casper, Suau, and McKenzie (2012). Bocarro and colleagues sought to examine the relations of schools' sports policy and environments to students' physical activity level measured by the System for Observing Play and Leisure in Youth (SOPLAY). Participants were 6,735 middle schoolers observed from four middle schools with similar socio-demographic backgrounds (e.g., racial/ethnic composition, SES). One interesting result was that schools' sports policy was significantly related to the level of students' physical activity (i.e., MVPA) among male students, but not among female students, implying significant gender difference. However, despite its importance, the impact of school sports policy or climate on or its link to student academic achievement still remains unknown or unclear.

Limitations of the Literature and Focus of This Study

Although nationally published or released position statements, guidelines, and recommendations called for schools to play a greater role in promoting physical activity through physical education to prevent or reduce sedentary lifestyle or physical inactivity and hence health problems (e.g., obesity) for children and adolescents, many schools in the U.S. have decreased or eliminated physical education time or programs to increase students' standardized test scores (CDC, 2010c, 2010d, 2012; IOM, 2012a, 2012b, 2013a; NASPE, 2009f, 2009g, 2009h; NASPE & AHA, 2006, 2010, 2012; Rasberry et al., 2011; USDHHS, 2000, 2008, 2010a). Particularly since NCLB and CCSS, U.S. schools have faced tremendous pressures to improve students' academic achievement focused on core subjects such as reading/ELA, mathematics, and science. Despite state or district mandates on physical education programs, schools have tried to promote academic achievement by increasing the time allocated to those core subjects while decreasing the time allocated to physical education. According to Argyris and Schön's (1974) theory of action, schools' current actions of decreasing or eliminating physical education time or programs to increase students' academic achievement should be tested and evaluated in order for schools to effectively manage their actions to maximize intended outcomes (e.g., enhanced learning environments, higher standardized test scores).

It seemed that the decreased allocated time for physical education was determined upon the sparse evidence that reducing or eliminating physical education time or programs and replacing them with core academic courses enhances student academic achievement. The findings of previous studies have consistently revealed that the decreased time in physical education was not positively linked to the increased academic achievement (e.g., Stevens, To, Stevenson, & Lochbaum, 2008; Trost, 2007, 2009). It is also noteworthy that the increased time in physical education was not negatively linked to academic achievement, and in some or more cases, was positively associated with academic achievement as well as school or classroom behaviors (e.g., Shephard, 1997). Considering these findings on the positive or neutral relations and academic benefits, physical education researchers and practitioners have suggested that schools not decrease the allocated time for physical education to increase instructional time for core subjects (e.g., Trost & van der Mars, 2009). Raine, Lee, Saliba, Chaddock-Heyman, Hillman, and Kramer (2013) recently claimed that "reducing or eliminating physical education in schools may not be the best way to ensure educational success among our young people" (p. 5). Physical educators have further proposed that increasing time in physical education might help improve student academic achievement without risk of hindering academic performance (e.g., Smith & Lounsbery, 2009; Strong et al., 2005; Trudeau & Shephard, 2008).

Although numerous previous studies have examined the roles and benefits of physical education and its impact on or link to elementary students' academic achievement, there are several limitations in previous studies. First, although schools' allocated time for physical education has been frequently used to examine its relation to students' academic achievement in the relevant literature, *none* of the literature in the area of physical education used allocated time as a *policy requirement* for *high school graduation*. Given the importance of assessing schools' current policies and practices on time requirements of physical education, it is not clear whether these actions of schools are effective in accomplishing their various goals and desired outcomes such as students' health promotion and ultimately academic achievement through regular participation in physical activity.

Next, the increasingly proven positive link of physical education participation to student academic achievement was observed mostly in K–5 school settings. Therefore, it remains unclear whether secondary students can receive academic benefits from participating in more physical education just as elementary students do. Since engagement in physical education has been the least and has drastically decreased during high school as compared to during elementary and middle schools, it is important to investigate the relation between physical education requirements and academic achievement especially with high schoolers. Given that adolescence is a transitional phase of dramatically and dynamically physical, physiological, psychological or emotional, social, and especially cognitive development, declines in physical activity or sports that begin during adolescence have major implications for adolescents' academic or non-academic achievement and further adults' health or lifestyles (Blakemore & Choudhury, 2006; Casey, Eime, Payne, & Harvey, 2009; Dohle & Wansink, 2013; Kimm et al., 2002; Kirby, Levin, & Inchley, 2012; Marsh & Kleitman, 2002; Paus, 2005; Steinberg, 2005; Yurgelun-Todd, 2007). Proactive approaches are needed to promote or at least maintain school-based physical activities, particularly physical education, overall health, and academic performance for adolescents who spend most of their daytime hours at school (e.g., Daley, 2002; Donnelly & Lambourne, 2011; PCFSN, 2012).

Another limitation was that most previous studies have examined the relationship between physical education and student academic achievement using two-sample *t*-tests or correlation-based analyses, thus hardly controlling for other potential factors such as family and school environments as well as student personal characteristics which might directly or indirectly affect or be linked to academic achievement. Given that families and schools have been recognized as strong social environments for high schoolers that influence students' academic achievement, relevant social environmental factors should be carefully considered and rigorously controlled when examining the relation between physical education and academic achievement. Additionally, it was difficult to generalize the results on the association between physical education and student academic achievement because of previous studies designed and conducted mostly with small sample sizes or number of participants.

Lastly, it is not well established whether the positive relationship between physical education and academic achievement is true for both male and female students in secondary school. During elementary school, previous research has found that female students received more academic benefits from participating in physical education or other physical activities than male students (Carlson et al., 2008; Shephard, 1996). It is interesting to note, however, that physical activity for female students drastically decreased during adolescence (Kimm et al., 2002; Young, Felton, Grieser, Elder, Johnson, Lee, & Kubik, 2007). Given that female adolescent students' enrollment rate and physical activity level were lower than male adolescent students in and during physical education classes (CDC, 2012; Eaton et al., 2012; Hannon & Ratliffe, 2005; McKenzie et al., 2000), respectively, the relation between physical education engagement and academic achievement may not be the same between male and female students in secondary school. Therefore, it is also important to investigate whether there is gender difference in the association between physical education requirements and academic achievement among high school students.

Accordingly, this study targeted high school students to examine whether the school's physical education requirements are related to students' academic achievement after controlling for other individual and social environmental factors. For this purpose, the study used a multilevel analysis from a large, nationally representative sample of U.S. high schoolers.

Chapter 3: Method

This chapter outlines the methods used to examine the relationships between a school's physical education graduation requirements and students' academic achievement. Specifically, this study addressed four research hypotheses:

Hypothesis 1: Students who attend schools with more physical education graduation requirements are likely to have higher academic achievement growth in reading than those who attend schools with less or no physical education graduation requirements.

Hypothesis 2: Students who attend schools with more physical education graduation requirements are likely to have higher academic achievement growth in mathematics than those who attend schools with less or no physical education graduation requirements.

Hypothesis 3: Students who attend schools with more physical education graduation requirements are likely to have higher academic achievement growth in science than those who attend schools with less or no physical education graduation requirements.

Hypothesis 4: The relationships between physical education graduation requirements and three measures of student academic achievement are likely to differ by gender.

This chapter describes the data, measures, analyses, and statistical models used to address the four research hypotheses of the study. Specifically, it begins with a description of the data used in the study followed by a description of the analytic sample. A description of measures such as dependent, independent, and control variables used in the study follows. Then, the chapter provides a description of analyses including descriptive and hierarchical linear modeling (HLM) analyses employed in the study. The chapter concludes with a description of statistical models including Models 1 through 3 employed in the study.

Data

Data Description

This research used data from the National Education Longitudinal Study of 1988 (NELS:88), sponsored by the National Center for Education Statistics (NCES), a division of the U.S. Department of Education (USED). NELS:88 is a general-purpose survey designed to provide a broad range of information about the educational experiences of adolescents and young adults in public and private educational institutions (Curtin, Ingels, Wu, & Heuer, 2002). The NELS data focus on students' educational, vocational, and personal development from middle school to high school; relevant factors such as individual/student characteristics, family environment, and school environment; and subsequent transition to postsecondary institutions and the workforce. Beginning in 1988, NCES surveyed almost 25,000 8th-grade students from over 1,000 middle schools in the base year and sampled, on average, 23 student participants from each school. In 1990, NCES conducted the first follow-up survey with more than 20,000 10th-grade students from over 1,200 high schools. In 1992, NCES surveyed more than 18,000 12th-grade students from high schools in the second follow-up and additionally collected coursework and transcript records from school administrators. In 1994 and 2000, NCES performed the third follow-up and fourth follow-up surveys, respectively, after students had graduated from high schools.

It is worth noting that NELS:88 has three distinctive features. First, NELS:88 is a longitudinal study, surveying the same students, their parents, their teachers, and their school administrators over time. In the base year (1988), NCES surveyed and tested middle school students (8th graders) in reading, mathematics, science, and social studies.

In the first follow-up (1990), NCES resurveyed and retested the base-year cohort of students, including a freshened sample (10th graders) that made the study representative of high school sophomores, in the same four academic subjects. NCES also resurveyed and retested the first follow-up cohort of students in the second follow-up (1992, 12th graders). Further, NCES resurveyed the second follow-up cohort of students in the third follow-up (1994) and fourth follow-up (2000). Next, NELS:88 is an integrated, multilevel study that gathered data from multiple respondents at multiple levels. For example, NCES obtained data not only from students but also from their parents, teachers, and school administrators. Data from parents, teachers, and school administrators offer rich information about students' personal, academic, social, cultural, and economic environments. This multilevel focus helps researchers and practitioners gain a better understanding, along with a more comprehensive picture, of various individual and social environmental factors that may influence or be related to students' academic development and growth. Lastly and most importantly, unlike other national secondary longitudinal studies (e.g., ELS:2002, HSLS:2009), NELS:88 provides data solely on the physical education requirements, not combined with health education or other subjects' requirements, which permits an examination of the relationship between a school's physical education graduation requirements and students' academic achievement – the focus of this study.

Analytic Sample

Because this study examined the relationship between physical education graduation requirements and student academic achievement during high school, data were drawn from the base year (1988, 8th grade) and the second follow-up (1992, 12th grade) in the NELS dataset. Additionally, this study used high school transcript data collected in the second follow-up. For the purpose of analysis, this study included students who (1) stayed in the same high school and (2) had data on dependent variables (i.e., achievement test scores) in both 8th grade and 12th grade in each relevant academic subject. This study also included schools that had at least five NELS-sampled students per school. Further, cases with missing values on any of the independent and control variables at both level 1 (student level) and level 2 (school level) were excluded from the analysis. As a result of all these restrictions, the final analytic sample in the study comprised a total of 6,274 students from 653 schools in reading, 6,282 students from 653 schools in mathematics, and 6,249 students from 653 schools in science. There was an average of 9.6 students per school for each sample.

Students in the analytic sample were very similar across three academic subjects (i.e., reading, math, science) and few differences were found in student, family, and school characteristics variables. Therefore, students in the analytic sample in reading were used to compare those in the full sample. For student socio-demographic background variables, there were fewer minority students in the analytic sample (15.4%) than in the full sample (26.1%), whereas little difference was found in the proportion of male and female students in between the analytic sample and the full sample. There was little difference in health status between students in the analytic sample and those in the full sample. For student academic background variables, students in the analytic sample (54.7%) were placed in academic program more than those in the full sample (40.6%). Notably, students in the analytic sample had higher levels of 8th-grade and 12th-grade academic achievement in all three core subjects than those in the full sample. The differences in student academic achievement were 2.73 points and 2.49 points for 8th-grade and 12th-grade reading achievement, 4.14 points and 4.07 points for 8th-grade and 12th-grade mathematics achievement, and 1.72 points and 1.59 points for 8th-grade and 12th-grade science achievement. Further, students in the analytic sample earned more total Carnegie units in all three academic subjects than those in the full sample. The differences in total Carnegie units earned were 0.36 units for reading, 0.42 units for mathematics, and 0.42 units for science. For family characteristics variables, students in the analytic sample (71.3%) lived with two parents more than those in the full sample (62.7%). There was no difference in family SES in between students in the analytic sample and those in the full sample.

For school characteristics variables, students in the analytic sample (17.1%) attended private schools more than those in the full sample (12.8%). Additionally, students in the analytic sample (17.6%) attended large schools less than those in the full sample (26.6%). There was little difference in the proportion of students who attended schools requiring 1-year physical education for graduation in between the analytic sample (31.4%) and the full sample (30.8%). Also, there was little difference in the proportion of students who attended schools requiring more than 1-year physical education for graduation in between the analytic sample (54.9%) and the full sample (53.9%). Given the comparison of the analytic sample to the full sample, the findings of this study may generalize to high school students who are more academically and racially/ethnically advantaged than those in the full sample. With the analytic sample, descriptive statistics for all variables used in the analysis are presented in Chapter 4.

Measures

Dependent Variables

The dependent variables in this study were high school students' academic achievement in three core subjects – reading, mathematics, and science. This study chose these academic subjects because they (1) are key to general and STEM education, (2) are important to students' academic/educational and career successes, (3) differ from one another in nature, (4) are differentially affected by school environmental factors, and (5) have persistent gender difference in academic achievement for gender-specific measures. Although NELS:88 provides data on academic achievement in social studies, this research focused on reading, mathematics, and science to limit the complexity of results as in previous studies (e.g., Lee et al., 1997). Particularly, this study used academic achievement growth or gains in those three core subjects, as measures of students' academic achievement, indicating student learning in the relevant subject areas over the high school period. There are differences of opinion in the literature about using gain scores and pre-post scores in educational research partly because the analyses using these two different measures can yield inconsistent results (Knapp & Schafer, 2009). Further, Knapp and Schafer (2009) assert that there is an important distinction in research questions when using gain scores and when using pre-post scores. Research questions using gain scores focus on the effect of a particular treatment on the *change* from pre scores to post scores while research questions using pre-post scores focus on the effect of a particular treatment on the *post scores*. Given that this study was more interested in whether a school's physical education graduation requirements are related to the *change* of students' academic achievement over the high school period, gain scores were used in the analysis.[1] Moreover, although achievement growth or gain has been frequently used as a measure of student academic achievement in previous school effects studies (e.g., Lee & Smith, 1997; Werblow & Duesbery, 2009), it has been rarely examined in previous research on the relationship between physical education and academic achievement. Therefore, the results of this study may be conducive to extending the literature regarding whether allocated time for physical education is related to student academic achievement growth.

The academic achievement test scores in the study were obtained from the IRT estimates on the NELS cognitive tests that are continuous measures developed by the Educational Testing Service (ETS) (Curtin et al., 2002; Rock & Pollack, 1995). Especially, the IRT-estimated number right score was used in the analysis representing an estimated number correct score that a student would receive if he/she had taken all the items in the total item pool of each academic subject (Ingels, Dowd, Baldridge, Stipe, Bartot, & Frankel, 1994). The IRT-estimated number right score was selected because it (1) allows calculating academic achievement growth and (2) is easy to interpret. The IRT-estimated number right score is vertically scaled in different grades (years of schooling) and thus the difference scores between 8th grade and 12th grade can be assumed to represent students' academic achievement growth.

Given this, a new variable of academic achievement growth (i.e., gain score) in the study is a continuous measure that was created by subtracting students' 8th-grade IRT-estimated number right scores from their 12th-grade IRT-estimated number right scores. For example, the academic achievement growth in reading was calculated by

[1] This study also ran HLM analyses using pre-post test scores. There were no differences in level-1 and level-2 coefficients (except for intercept coefficients) in HLM analyses comparing between gain scores and pre-post scores.

subtracting students' reading test scores in 8th grade (BY2XRIRR) from their reading test scores in 12th grade (F22XRIRR). Likewise, the academic achievement growth in mathematics and science was computed by subtracting students' mathematics (BY2XMIRR) and science (BY2XSIRR) test scores in 8th grade from their mathematics (F22XMIRR) and science (F22XSIRR) test scores in 12th grade, respectively.

Independent Variable

Physical education graduation requirement. The key independent variable of interest was a school's physical education graduation requirements, particularly the amount/year of physical education coursework required for graduation, which is neither combined nor confounded with health education graduation requirements. Physical education graduation requirement variable (F1C70J) is originally constructed on a 7-point scale: 0 = course not offered, 1 = none (course offered but not required), 2 = less than a year, 3 = one year, 4 = two years, 5 = three years, and 6 = four years. Given that sample sizes of schools neither offering physical education course nor requiring physical education for graduation are too small to be included as a category, these two categories were collapsed. Therefore, the physical education graduation requirement variable was recoded into six categories such as course not offered or none, less than a year, one year, two years, three years, and four years. One-year physical education graduation requirement was chosen as a reference category because it has been most commonly adopted and implemented in U.S. high schools (NASPE & AHA, 2006, 2010, 2012), which may help better explain the statistical significance and association with student academic achievement in comparison with other physical education graduation requirement categories. Accordingly, five dummy coded variables were created and included in the analysis.

Control Variables

A series of student-level (including family-related) and school-level control variables were selected and included in the analysis based on previous studies. These control variables have been found to have causational or non-causational relations to students' academic achievement and were described in the previous literature review chapter. By including all these control variables into the models, this study took various other confounding factors into account in the analysis to better understand the value or benefits of physical education contributing to students' academic achievement growth in reading, mathematics, and science. In the following sub-sections, a detailed explanation about the control variables used in this study is provided.

Student personal characteristics

Based on previous research, this study selected and included student-level control variables in the analysis: students' socio-demographic backgrounds (i.e., gender, minority status), students' health background (i.e., health status including illness or disability), students' motivational background (i.e., academic aspiration), and students' academic backgrounds (i.e., school program placement, prior academic achievement, coursetaking such as total Carnegie units and course level in the relevant academic subjects). Especially, students' sports backgrounds (i.e., school sports participation, non-school sports participation) were selected and included in the analysis to avoid their confounding effects with physical education requirements on academic achievement. Also, students' academic self-concept, described in the literature review, was considered but not included in the analysis due to the unavailability of data in the NELS dataset.

Gender. Researchers have claimed that students' gender was one important socio-demographic factor to explain variability of academic achievement and hence has been widely employed in previous studies (e.g., Carlson et al., 2008; Eitle, 2005; Shephard, 1996; Tremblay et al., 2000). Given this, students' gender was controlled in the analysis. A composite variable of gender (F2SEX) was recoded as 0 = male and 1 = female. Male students were chosen as a reference group.

Minority status. Students' race/ethnicity has been recognized as another important socio-demographic factor explaining variability of academic achievement in previous research (e.g., Eaton et al., 2006a, 2006b, 2012; Peng & Wright, 1994; Ripski & Gregory, 2009). Generally, students in White or Asian racial/ethnic groups have consistently shown to present higher academic achievement than those in other racial/ethnic groups. Because sample sizes of some minority racial/ethnic groups (e.g., Asian/Pacific Islander, American Indian/Alaskan native) are typically small for meaningful analyses, previous studies have frequently used minority status rather than race/ethnicity itself. Given the small sample sizes of Asian/Pacific Islander and American Indian/Alaskan native students to be included as a category, this study also created a new variable of minority status and included it into the analysis. Specifically, the new variable of minority status was created using a composite variable of race/ethnicity (F2RACE1). The race/ethnicity variable is originally constructed on a 5-point scale: 1 = Asian/Pacific Islander, 2 = Hispanic, 3 = Black-not Hispanic, 4 = White-not Hispanic, and 5 = American Indian/Alaskan native. In order to create the new minority status variable, the race/ethnicity variable was recoded into two categories such as 0 = non-minority students (White-not Hispanic or Asian/Pacific Islander) and 1 = minority students (Hispanic, Black-not Hispanic, or American Indian/Alaskan native). Non-minority students were chosen as a reference group.

Health status. Previous research has demonstrated that students' health problems were linked to or affected their school functioning (e.g., Case & Paxson, 2006; Crosnoe, 2006; Geier et al., 2007; Taras & Potts-Datema, 2005; Van Cleave, Gortmaker, & Perrin, 2010). Given this, students' health status has been recognized as one of the influential health-related factors on their academic achievement and hence was controlled in the analysis. Students' health status is measured asking whether they became seriously ill or disabled in the last two years. Health status variable (F2S96G) was recoded as 0 = no (did not become seriously ill or disabled) and 1 = yes (became seriously ill or disabled). Students who did not become seriously ill or disabled were chosen as a reference group.

Academic aspiration. Students' academic aspiration has been found to be an important motivational factor affecting academic achievement in previous studies (e.g., Abu-Hilal, 2000; Brookover et al., 1967; Liu et al., 2009; Quaglia, 1989) and hence was controlled in the analysis. Students' academic aspiration is measured asking how far in school students think they will get. Academic aspiration variable (F2S43) is originally constructed on a 11-point scale: 1 = less than high school, 2 = high school only, 3 = less than 2-year school, 4 = more than 2-year school, 5 = trade school degree, 6 = less than 2-year college, 7 = more than 2-year college, 8 = finish college, 9 = master's or equivalent, 10 = Ph.D., M.D., or other, and 11 = don't know. Students who responded "don't know" were dropped and their responses were treated as missing, resulting in 10 categories.

Given that sample sizes of some categories (e.g., less than high school, less than 2-year school, less than 2-year college) are too small to be included as a category, those categories were collapsed. Also, to enhance interpretation of results, the academic aspiration variable was recoded into three categories such as low academic aspiration ('less than high school' through 'trade school degree'), medium academic aspiration ('less than 2-year college' through 'finish college'), and high academic aspiration (master's or equivalent, Ph.D., M.D., or other). Students who have low academic aspirations were chosen as a reference group and thus two dummy coded variables were created and included in the analysis.

School program placement. Given that high school curriculum varied by students' school program or track placement in school, students' academic achievement has been differentially affected by their school program placement (e.g., Gamoran, 1992; Mosqueda, 2010; Rowan et al., 1997) and hence was controlled in the analysis. Students' school program placement is measured asking which school program students are currently enrolled in or last attended, indicating their current or last track placement. School program placement variable (F2HSPROG) is originally constructed on a 7-point scale: 1= general high school program, 2 = academic program, 3 = vocational/technical program, 4 = other specialized program, 5 = special education program, 6 = alternative/dropout prevention program, and 7 = don't know. Students who responded "don't know" were dropped and their responses were treated as missing, resulting in six categories. Given that sample sizes of some categories (e.g., other specialized program, special education program, alternative/dropout prevention program) are too small to be included as a category, those categories were collapsed and combined with a vocational/technical program category. Therefore, the school program placement variable was recoded into three categories such as general high school program, academic program, and other program (vocational/technical, other specialized, special education, or alternative/dropout prevention). Students who are currently enrolled in or last attended academic programs were chosen as a reference group and thus two dummy coded variables were created and included in the analysis.

Prior academic achievement. In previous school effects studies (e.g., Elliott, 1998; Mussoline & Shouse, 2001; Lee et al., 2006; O'Conner & Miranda, 2002; Pong, 1998), students' prior academic achievement has been widely used as one of the strongest predictors of their post academic achievement and hence was controlled in the analysis. Specifically, students' IRT-estimated number right scores in 8th-grade reading (BY2XRIRR), 8th-grade mathematics (BY2XMIRR), and 8th-grade science (BY2XSIRR), as continuous measures, were included to control for students' prior or initial academic abilities at the beginning of high school year. For example, when the dependent variable was students' reading achievement growth, their 8th-grade reading test scores were controlled in the analysis. Likewise, when the dependent variables were students' mathematics and science achievement growth, their 8th-grade mathematics and 8th-grade science test scores were controlled in the analysis, respectively.

Coursetaking. Given different coursetaking by high school students and its impact or link to academic achievement (e.g., Lee et al., 1997; Rowan et al., 1997), their coursetaking (i.e., total Carnegie units, course level) in the relevant academic subjects was controlled in the analysis. Total Carnegie units earned in reading (F2RENG_C), mathematics (F2RMAT_C), and science (F2RSCI_C) by the end of high school year, as continuous measures, were included in the analysis. The new levels of courses taken in mathematics and science by the end of high school year were also created and included in the analysis while the level of courses taken in reading could not be included due to the unavailability of data. In order to enhance interpretation of results and make them meaningful, the new levels of mathematics and science courses were created. Specifically, the NAEP-equivalent mathematics and science classifications were used to separate appropriate courses for coursetaking measures (Burkam & Lee, 2003). The level of mathematics course was recoded into four categories: no mathematics course taken or low-level mathematics course (i.e., other math courses), middle-level 1 mathematics course (i.e., geometry, algebra I), middle-level 2 mathematics course (i.e., algebra II), and advanced-level mathematics course (i.e., trigonometry, pre-calculus, calculus). Students who took no mathematics course or low-level mathematics course were chosen as a reference group and thus three dummy coded variables were created and included in the analysis. The NELS variables of Carnegie units in mathematics used in the study are: F2ROMA_C (other math courses), F2RGEO_C (geometry), F2RAL1_C (algebra I), F2RAL2_C (algebra II), F2RTRI_C (trigonometry), F2RPRE_C (pre-calculus), and F2RCAL_C (calculus). Similarly, the level of science course taken was recoded into three categories: no science course taken or low-level science course (i.e., earth science, other science courses), middle-level science course (i.e., biology), and advanced-level science course (i.e., chemistry, physics). Students who took no science course or low-level science course were chosen as a reference group and thus two dummy coded variables were created and included in the analysis. The NELS variables of Carnegie units in science used in the study are: F2ROSC_C (other science courses), F2REAR_C (earth science), F2RBIO_C (biology), F2RCHE_C (chemistry), and F2RPHY_C (physics).

Sports participation. In addition to physical education programs, schools provide secondary students with various physical activities through extracurricular sports or after-school physical activity programs (e.g., Broh, 2002; NASPE & AHA, 2006, 2010, 2012; Powers et al., 2002; SHAPE America, 2013a). Some studies have reported that more than half of high school students participate in at least one sports team inside or outside school (e.g., CDC, 2012; Eaton et al., 2012). Other studies have found that high school adolescents' participation in varsity sports was one of the strongest predictors of adults' physical activity along with fewer outpatient visits (e.g., Dohle & Wansink, 2013). Further, research has shown a potential effect of sports participation on or its link to student academic achievement and hence was considered as one of the important individual factors (e.g., Barber et al., 2001; Broh, 2002; Daley & Ryan, 2000; Stephens & Schaben, 2002). By controlling students' participation in school and non-school sports in the analysis, its confounding effect with physical education requirements on academic achievement could have been avoided.

Students' participation in school sports is measured asking whether they participated in specific sports sponsored by school. In order to enhance interpretation of results, a new composite variable of school sports participation was created by summing five items: F2S30AA (participation in interscholastic team sports), F2S30AB (participation in interscholastic individual sports), F2S30AC (participation in interscholastic cheerleading/pompom/drill team), F2S30BJ (participation in intramural team sports), and F2S30BK (participation in intramural individual sports).

Students' participation in non-school sports is measured asking how frequently they participated in sports not sponsored by school. A new composite variable of non-school sports participation was created using two items: F2S33K (frequency of taking non-school sponsored sports lessons) and F2S33L (frequency of participating in non-school sponsored sports). Each of these separate but related items is originally constructed on a 4-point scale: 1 = never/rarely, 2 = less than once a week, 3 = once/twice a week, and 4 = almost every day. Given that a typical minimum frequency of regular participation in non-school sports is once a week, the non-school sports participation variable was recoded into two categories such as 0 = never/rarely or less than once a week and 1 = once/twice a week or almost every day. Students who participated in non-school sports never/rarely or less than once a week were chosen as a reference group.

Family environment

Students' academic achievement has been influenced by their family backgrounds as well as their personal characteristics. Based on previous research focusing on the impact of family background on or its relation to student academic achievement, family-related control variables were selected and included in the analysis: family's socio-demographic backgrounds (i.e., family SES, family structure) and parents' involvement (i.e., parental expectation). Given the multidimensional nature and mixed or inconsistent results of parent involvement, particularly parental home involvement, parental involvement and its effect on or link to student academic achievement should be rigorously examined and cautiously interpreted (e.g., Hill et al., 2004; Lee & Bowen, 2006). It is further recommended to focus on the association between parental *school* involvement and student academic achievement, and to measure and examine various kinds, dimensions, or predictors of parent involvement in *school* separately, not combinedly (Desimone, 1999; Fan, 2001; Fan & Chen, 2001; McNeal, 1999). For simplicity and clarity, thus, parental expectation for a child's education as the strongest parental (school) involvement was selected and included in the analysis.

Family socioeconomic status. Family socioeconomic status (SES) has been found to be one of the strongest socio-demographic factors to explain student academic achievement in previous studies (e.g., Darling et al., 2005; Kim et al., 2003; Martin et al., 2007; Rouse & Barrow, 2006) and hence was controlled in the analysis. Family SES is measured using the second follow-up parent questionnaire data. A composite variable of family SES (F2SES2) is a continuous measure that was created from five items: parents' educational level (F2P101A, F2P101B), parents' occupation or job (F2P13, F2P16), and total household or family income (F2P74).

Family structure. Given that students from intact families showed higher academic performance than those from single-parent families, family structure has been recognized as another important socio-demographic factor explaining student academic achievement (e.g., Ham, 2003; McLanahan, 1985; O'Conner & Miranda, 2002; Pong & Ju, 2000; Sun & Li, 2009; Walberg & Greenberg, 1996) and hence was controlled in the analysis. Family structure is measured asking who live(s) with a child in the same household. A composite variable of family structure (F2FCMP) was created from 10 items: F2P8A (teenager's father) through F2P8H (teenager's boyfriend/girlfriend), F2P2 ("How much of the time does the teenager named on the front cover live with you?"), and F2P3 ("With whom does the teenager named on the front cover live most of the time when he/she does not live with you?"). The family structure variable is originally constructed on a 7-point scale: 1 = mother and father, 2 = mother and other male, 3 = father and other female, 4 = other female and male families/relatives, 5 = mother/other female, 6 = father/other male, and 7 = independent teen. Given that sample sizes of some categories (e.g., father and other female, other female and male families/relatives, father/other male, independent teen) are too small to be included as a category, those categories were collapsed. Also, to enhance interpretation of results, the family structure variable was recoded into three categories such as mother and father (two-parent), mother/other female or father/other male (single-parent), and mother and other male, father and other female, other female and male families/relatives, or independent teen (other-parent/independent teen). Students who live with both their mother and father were chosen as a reference group and thus two dummy coded variables were created and included in the analysis.

Parental expectation. Among various parental involvement, parents' expectations for children's education appeared to have a major impact on or the strongest positive relation to students' academic achievement in previous studies (e.g., Fan, 2001; Fan & Chen, 2001; Feuerstein, 2000; Flowers & Flowers, 2008; Holloway et al., 2008; Seginer & Vermulst, 2002; Seyfried & Chung, 2002; Singh et al., 1995) and hence was controlled in the analysis. Parental expectation for a child's education is measured asking how far in school a parent wants his/her child to go. The parental expectation variable (F2P61) is originally constructed on a 9-point scale: 1 = less than high school graduation, 2 = high school graduation, 3 = less than 2-year vocational/technical or business, 4 = 2-year or more vocational/technical or business, 6 = less than 2-year college, 7 = 2-year or more college, 8 = finish college, 9 = master's degree, and 10 = Ph.D, M.D., or other profession.

Value 5 was not used in the recode for comparability with previous NCES studies in the NELS dataset (NCES, n.d.). Given that sample sizes of some categories (e.g., less than high school graduation, less than 2-year vocational/technical or business, less than 2-year college) are too small to be included as a category, those categories were collapsed. Also, to enhance interpretation of results, the parental expectation variable was recoded into three categories such as low parental expectation ('less than high school graduation' through '2-year or more vocational/technical or business'), medium parental expectation ('less than 2-year college' through 'finish college'), and high parental expectation (master's degree, Ph.D, M.D., or other profession). Parents who have low expectations were chosen as a reference group and thus two dummy coded variables were created and included in the analysis.

School environment

Based on previous school effects research, school-level control variables selected and included in the analysis were: schools' socio-demographic backgrounds (i.e., school type, school size, school urbanicity, school SES, minority student concentration, single-parent student concentration) and schools' academic background (i.e., school academic composition). Especially, schools' sports climate (i.e., school emphasis on sports) was selected and included in the analysis to avoid its confounding effect with physical education requirements on student academic achievement.

School type. Given that different school types provided different academic environments including curriculum, class size, and teacher quality, school type has been frequently used as one of the influential socio-demographic factors on student academic achievement (e.g., Benveniste, Carnoy, & Rothstein, 2003; Carolan, 2010; Haghighat, 2005; Mosqueda, 2010; Pong, 1997, 1998) and hence was controlled in the analysis. School type is measured based on the school classification. The school type variable (G12CTRL1) is originally constructed on a 5-point scale: 1 = public, 2 = Catholic, 3 = private-other religious, 4 = private-non-religious, and 5 = private-not ascertained. Given that sample size of public school is very large compared to the other schools and sample sizes of some categories (e.g., private-other religious, private-non-religious, private-not ascertained) are too small to be included as a category, those categories were collapsed. Also, to enhance interpretation of results, the school type variable was recoded into two categories such as 0 = public and 1 = private. Public schools were chosen as a reference group.

School size. Previous studies focusing on school effects have found the association between school size and student academic achievement (e.g., Lee & Smith, 1997; Ripski & Gregory, 2009; Werblow & Duesbery, 2009) and hence was controlled in the analysis. School size is measured based on the entire school enrollment. The school size variable (F1SCENRL) is originally constructed on a 9-point scale: 1 = 1 – 399, 2 = 400 – 599, 3 = 600 – 799, 4 = 800 – 999, 5 = 1,000 – 1,199, 6 = 1,200 – 1,599, 7 = 1,600 – 1,999, 8 = 2,000 – 2,499, and 9 = 2,500 or more. Given the large number of categories, the original school size variable was collapsed into fewer categories to enhance interpretation of results. Based on previous studies (e.g., Lee & Burkam, 2003; Lee & Smith, 1997), the school size variable was recoded into four categories such as small school size (1 – 599), medium school size (600 – 1,599), large school size (1,600 – 2,499), and very large school size (2,500 or more). Medium-size schools were chosen as a reference group and thus three dummy coded variables were created and included in the analysis.

School urbanicity. Previous research has reported the link of school urbanicity to student academic achievement (e.g., Pong, 1998; Sellström & Bremberg, 2006; Webster & Fisher, 2000; Werblow & Duesbery, 2009; Young, 1998) and hence was controlled in the analysis. School urbanicity is measured based on the urbanicity of the school area located, indicating metropolitan status. The school urbanicity variable (G12URBN3) is constructed on a 3-point scale: 1 = urban, 2 = suburban, and 3 = rural/outside MSA. Urban schools were chosen as a reference group and thus two dummy coded variables were created and included in the analysis.

School socioeconomic status. Previous studies have found the impact of schools' socioeconomic status (SES) on or its link to students' academic achievement above and beyond students' family SES (e.g., Haghighat, 2005; Ripski & Gregory, 2009; Rumberger & Palardy, 2005) and hence was controlled in the analysis. A new variable of school SES is a continuous measure that was created by aggregating the composite variable of family SES (F2SES2) into the school level. The aggregated family SES has been frequently used as a measure of schools' socioeconomic composition when the school SES was not available in the original dataset in previous research (e.g., Ma et al., 2008).

Minority student concentration. Concentration of minority students in school has been often used to take schools' socio-demographics into account in previous school effects studies (e.g., Lee & Burkam, 2003; Lee & Smith, 1997; Lee et al., 1997) and hence was controlled in the analysis. Although the percentage of minority students in school is a continuous measure, this variable was poorly distributed (i.e., non-normally distributed) and hence was transformed to a categorical variable. Based on previous research (e.g., Lee & & Bryk, 1989), schools that enroll 40% or more Hispanic, Black-not Hispanic, or American Indian/Alaskan native students were considered as high minority student concentration and schools with less than 40% students were considered as low minority student concentration. A new variable of minority student concentration was created using the composite variable of students' race/ethnicity (F2RACE1). The race/ethnicity variable is originally constructed on a 5-point scale: 1 = Asian/Pacific Islander, 2 = Hispanic, 3 = Black-not Hispanic, 4 = White-not Hispanic, and 5 = American Indian/Alaskan native. In order to create the new minority student concentration variable, however, the race/ethnicity variable was recoded as 0 = White-not Hispanic or Asian/Pacific Islander (non-minority students) and 1 = Hispanic, Black-not Hispanic, or American Indian/Alaskan native (minority students). The race/ethnicity variable was aggregated to the school level and then was recoded into two categories such as 0 = low minority student concentration (schools enrolling less than 40% minority students) and 1 = high minority student concentration (schools enrolling 40% or more minority students). Schools with low minority student concentration were chosen as a reference group.

Single-parent student concentration. Previous studies have demonstrated a relation between concentration of single-parent students in school and high schoolers' academic achievement (e.g., Pong, 1998) and hence was controlled in the analysis. Single-parent student concentration is measured asking school administrators what percentage of students live with single-parents in their schools. The single-parent student concentration variable (F2C23) is originally constructed on a 5-point scale: 1 = 0 – 10%, 2 = 11 – 24%, 3 = 25 – 49%, 4 = 50 – 74%, and 5 = 75 – 100%. In order to make interpretation of results meaningful, the single-parent student concentration variable was recoded into three categories such as low single-parent student concentration (0 – 24%), medium single-parent student concentration (25 – 49%), and high single-parent student concentration (50% or more) based on previous studies (e.g., Pong, 1998). Schools with low single-parent student concentration were chosen as a reference group and thus two dummy coded variables were created and included in the analysis.

School academic composition. Schools' academic composition has been identified as one of the influential factors on students' academic achievement and hence often used to examine the effects of various school environmental factors on or their links to academic achievement in previous studies (e.g., Hill, 2008; Lee & Burkam, 2003; Lee & Smith, 1996; Rowan et al., 1997; Rumberger & Palardy, 2005). Given this, schools' academic composition (i.e., average academic performance) was controlled in the analysis. A new variable of school academic composition is a continuous measure that was created by aggregating students' 8th-grade academic achievement in the relevant academic subjects into the school level. It should be noted that the school academic composition variable is different for each dependent variable. For example, in Model 1 where the dependent variable is students' reading achievement growth, their 8th-grade reading test scores were aggregated into the school level and included in Model 1. Likewise, in Models 1 and 2 where dependent variables are students' mathematics and science achievement growth, their 8th-grade mathematics and science test scores were aggregated into the school level and included in Models 2 and 3, respectively.

School emphasis on sports. Schools' sports policy or environment enhancing students' physical activities may often reflect school climate characteristics of sports as well as physical education (e.g., Bocarro et al., 2012). Given this, schools' climate emphasizing sports was controlled in the analysis to avoid its confounding effect with physical education requirements on student academic achievement. School emphasis on sports is measured asking school administrators the extent to which schools emphasize sports. The school emphasis on sports variable (F2C56J) is constructed on a 3-point scale: 1 = not accurate (do not emphasize sports), 2 = somewhat accurate (somewhat emphasize sports), and 3 = very accurate (very emphasize sports). Schools which do not emphasize sports were chosen as a reference group and thus two dummy coded variables were created and included in the analysis.

Analyses

Descriptive Analysis

Given that this study focused on the relationship between a school's physical education graduation requirements and students' academic achievement, schools were divided into six groups based on physical education graduation requirements: course not offered or none, less than a year, one year, two years, three years, and four years. Descriptive statistics such as means for continuous variables and proportions for categorical variables were calculated by six groups of schools in terms of student-level (including family-related) and school-level characteristics. This study used student panel weight (F2TRP1WT) that applied to those students who participated in the base year (1988, 8th grader) through the second follow-up (1992, 12th grader) with transcript data available. The student panel weight was normalized by dividing it by the mean of the weights. The normalized student panel weight was used to conduct descriptive analysis of student-level variables.

Hierarchical Linear Modeling Analysis

Given the nested structures of research questions (i.e., are students who attend schools with different physical education graduation requirements related to different levels of academic achievement growth?) and NELS data (i.e., students nested within schools), this study employed hierarchical linear modeling (HLM) as an analytic tool. HLM provides a significant improvement over ordinary least squares regression models in that it can effectively model the multilevel nature of data by estimating the effects at both the student level and the school level (Raudenbush & Bryk, 2002). For each set of the main research hypotheses guiding this study, two-level hierarchical analytic model analyses were conducted on three measures of students' academic achievement.

The HLM analyses on three dependent variables were conducted at two levels: student level (level 1) and school level (level 2). Specifically, the HLM analyses were conducted using the following steps. The first step was to run a fully unconditional model (FUM). FUM is a one-way analysis of variance (ANOVA) model with random effects and has no independent and control variables at both the student level and the school level. FUM decomposes the total variances in each of three measures of student academic achievement into variance attributable to students (within-school component) and variance attributable to schools (between-school component). The significant between-school component indicates that schools vary in terms of averaged students' academic achievement (e.g., some schools have better averaged academic achievement, but other schools do not). The proportion of variance in a dependent variable that exists between schools is referred to as the intraclass correlation coefficient (ICC) and ICC should be reviewed to justify the use of multilevel modeling. The ICC can be calculated as follows (Raudenbush & Bryk, 2002):

$$ICC = \frac{\tau_{00}}{\sigma^2 + \tau_{00}},$$

where σ^2 and τ_{00} represent within-school variance and between-school variance, respectively.

The second step was to add student-level (including family-related) variables into the level 1 model and school-level variables into the level 2 model. All the level 1 independent variables were estimated as fixed effects and only the intercept was estimated as a random effect. In other words, the effects of these level 1 independent variables were constrained to have the same effects on the dependent variables across level 2 while the intercept was allowed to vary across level 2. Given that the primary independent variable was a school's physical education graduation requirements (level 2 variable), grand-mean centering on level 1 variables was used in the analysis. Grand-mean centering is an appropriate centering method for examining the impact of group-level variables on dependent variables after controlling for level 1 variables (Enders & Tofighi, 2007). For school-level variables, grand-mean centered continuous measures and uncentered dummy coded measures were used in the analysis for ease of interpretation. In all HLM analyses, student data were weighted to correct the differential probability of selection. The normalized student panel weight was used in the analysis. Because the NELS data do not contain school weight, however, school data could not be weighted in the analysis. Previous studies have demonstrated, for instance, that the unweighted school data may result in possible biases of standard error estimates (e.g., Kalton, 1983). Based on the recent recommendations by Stapleton and Kang (2012), thus, school-level variables related to the sampling design for the schools were added to the analysis, reducing the biases of estimates (e.g., standard error estimates) associated with not incorporating stratification and school weight into the analysis.

Statistical Models

In order to address research hypotheses 1 through 3, the models with academic achievement growth in three core subjects as dependent variables were referred to as Model 1 (reading achievement growth), Model 2 (mathematics achievement growth), and Model 3 (science achievement growth), respectively. For research hypothesis 4, this study estimated Models 1 through 3 again with separate male and female data and thus gender was not used as a control variable. Using the notation of Raudenbush and Bryk (2002), each set of equations for the Models 1 through 3 is presented below. Table 4 also gives the details of variables used in three models.

Model 1: Reading achievement growth

Level 1 model:

$$
\begin{aligned}
ReadGrowth_{ij} = {} & \beta_{0j} + \beta_1 Female + \beta_2 Minority + \beta_3 Health + \beta_4 MedAcAsp + \beta_5 HgAcAsp + \beta_6 GenProg + \beta_7 OthProg \\
& + \beta_8 PriRead + \beta_9 UnitRead + \beta_{10} SchSpt + \beta_{11} NonSchSpt + \beta_{12} FamSES + \beta_{13} SglPar + \beta_{14} OthPar \\
& + \beta_{15} MedParExp + \beta_{16} HgParExp + r_{ij}
\end{aligned}
$$

Level 2 model:

$$
\begin{aligned}
\beta_{0j} = {} & \gamma_{00} + \gamma_{01} NoPE + \gamma_{02} L1PE + \gamma_{03} Y2PE + \gamma_{04} Y3PE + \gamma_{05} Y4PE + \gamma_{06} Private + \gamma_{07} SmSchSize + \gamma_{08} LgSchSize \\
& + \gamma_{09} VeLgSchSize + \gamma_{10} Suburban + \gamma_{11} Rural + \gamma_{12} SchSES + \gamma_{13} HgMnrStu + \gamma_{14} MedSglPar + \gamma_{15} HgSglPar \\
& + \gamma_{16} SchRead + \gamma_{17} SchSwEmSpt + \gamma_{18} SchVeEmSpt + \tau_{00}
\end{aligned}
$$

$$\beta_{1j} = \gamma_{10},\ \beta_{2j} = \gamma_{20},\ \beta_{3j} = \gamma_{30},\ \ldots\ldots,\ \beta_{16j} = \gamma_{160}$$

Model 2: Mathematics achievement growth

Level 1 model:

$$
\begin{aligned}
MathGrowth_{ij} = {} & \beta_{0j} + \beta_1 Female + \beta_2 Minority + \beta_3 Health + \beta_4 MedAcAsp + \beta_5 HgAcAsp + \beta_6 GenProg + \beta_7 OthProg \\
& + \beta_8 PriMath + \beta_9 UnitMath + \beta_{10} AdvMath + \beta_{11} Mid2Math + \beta_{12} Mid1Math + \beta_{13} SchSpt + \beta_{14} NonSchSpt \\
& + \beta_{15} FamSES + \beta_{16} SglPar + \beta_{17} OthPar + \beta_{18} MedParExp + \beta_{19} HgParExp + r_{ij}
\end{aligned}
$$

Level 2 model:

$$
\begin{aligned}
\beta_{0j} = {} & \gamma_{00} + \gamma_{01} NoPE + \gamma_{02} L1PE + \gamma_{03} Y2PE + \gamma_{04} Y3PE + \gamma_{05} Y4PE + \gamma_{06} Private + \gamma_{07} SmSchSize + \gamma_{08} LgSchSize \\
& + \gamma_{09} VeLgSchSize + \gamma_{10} Suburban + \gamma_{11} Rural + \gamma_{12} SchSES + \gamma_{13} HgMnrStu + \gamma_{14} MedSglPar + \gamma_{15} HgSglPar \\
& + \gamma_{16} SchMath + \gamma_{17} SchSwEmSpt + \gamma_{18} SchVeEmSpt + \tau_{00}
\end{aligned}
$$

$$\beta_{1j} = \gamma_{10},\ \beta_{2j} = \gamma_{20},\ \beta_{3j} = \gamma_{30},\ \ldots\ldots,\ \beta_{19j} = \gamma_{190}$$

Model 3: Science achievement growth

Level 1 model:

$$
\begin{aligned}
SciGrowth_{ij} = {} & \beta_{0j} + \beta_1 Female + \beta_2 Minority + \beta_3 Health + \beta_4 MedAcAsp + \beta_5 HgAcAsp + \beta_6 GenProg + \beta_7 OthProg \\
& + \beta_8 PriSci + \beta_9 UnitSci + \beta_{10} AdvSci + \beta_{11} MidSci + \beta_{12} SchSpt + \beta_{13} NonSchSpt + \beta_{14} FamSES \\
& + \beta_{15} SglPar + \beta_{16} OthPar + \beta_{17} MedParExp + \beta_{18} HgParExp + r_{ij}
\end{aligned}
$$

Level 2 model:

$$\beta_{0j} = \gamma_{00} + \gamma_{01} NoPE + \gamma_{02} L1PE + \gamma_{03} Y2PE + \gamma_{04} Y3PE + \gamma_{05} Y4PE + \gamma_{06} Private + \gamma_{07} SmSchSize + \gamma_{08} LgSchSize$$
$$+ \gamma_{09} VeLgSchSize + \gamma_{10} Suburban + \gamma_{11} Rural + \gamma_{12} SchSES + \gamma_{13} HgMnrStu + \gamma_{14} MedSglPar + \gamma_{15} HgSglPar$$
$$+ \gamma_{16} SchSci + \gamma_{17} SchSwEmSpt + \gamma_{18} SchVeEmSpt + \tau_{00}$$

$\beta_{1j} = \gamma_{10}$, $\beta_{2j} = \gamma_{20}$, $\beta_{3j} = \gamma_{30}$, ……, $\beta_{18j} = \gamma_{180}$

Table 4

Details of Variables Used in Three Models

Variable Name	Description
Dependent variables (Student academic achievement)	
ReadGrowth	Student's reading achievement growth, an IRT-estimated number right gain score between 8th grade and 12th grade, a new continuous variable
MathGrowth	Student's math achievement growth, an IRT-estimated number right gain score between 8th grade and 12th grade, a new continuous variable
SciGrowth	Student's science achievement growth, an IRT-estimated number right gain score between 8th grade and 12th grade, a new continuous variable
Independent variable (PE graduation requirements)	
NoPE	School's PE graduation requirement, a dummy variable (0 = one year, 1 = course not offered or none)
L1PE	School's PE graduation requirement, a dummy variable (0 = one year, 1 = less than a year)
Y2PE	School's PE graduation requirement, a dummy variable (0 = one year, 1 = two years)
Y3PE	School's PE graduation requirement, a dummy variable (0 = one year, 1 = three years)
Y4PE	School's PE graduation requirement, a dummy variable (0 = one year, 1 = four years)
Student-level control variables (Student personal characteristics)	
Female	Student's gender, a composite & dummy variable (0 = male, 1 = female)
Minority	Student's minority status, a new dummy variable (0 = non-minority, 1 = minority)
Health	Student's health status, a dummy variable (0 = no/did not become seriously ill or disabled, 1 = yes/became seriously ill or disabled)
MedAcAsp	Student's academic aspiration, a dummy variable (0 = low academic aspiration, 1 = medium academic aspiration)
HgAcAsp	Student's academic aspiration, a dummy variable (0 = low academic aspiration, 1 = high academic aspiration)

GenProg	Student's school program placement, a dummy variable (0 = academic program, 1 = general program)
OthProg	Student's school program placement, a dummy variable (0 = academic program, 1 = other program)
PriRead	Student's prior reading achievement, an IRT-estimated number right score in 8th grade, a continuous variable
PriMath	Student's prior math achievement, an IRT-estimated number right score in 8th grade, a continuous variable
PriSci	Student's prior science achievement, an IRT-estimated number right score in 8th grade, a continuous variable
UnitRead	Total Carnegie units a student has earned in reading, a continuous variable
UnitMath	Total Carnegie units a student has earned in math, a continuous variable
UnitSci	Total Carnegie units a student has earned in science, a continuous variable
AdvMath	Advanced-level courses a student has taken in math, a new dummy variable (0 = no math course taken or low-level math course, 1 = advanced-level math course)
Mid2Math	Middle-level 2 courses a student has taken in math, a new dummy variable (0 = no math course taken or low-level math course, 1 = middle-level 2 math course)
Mid1Math	Middle-level 1 courses a student has taken in math, a new dummy variable (0 = no math course taken or low-level math course, 1 = middle-level 1 math course)
AdvSci	Advanced-level courses a student has taken in science, a new dummy variable (0 = no science course taken or low-level science course, 1 = advanced-level science course)
MidSci	Middle-level courses a student has taken in science, a new dummy variable (0 = no science course taken or low-level science course, 1 = middle-level science course)
SchSpt	Student's school sports participation, a new composite & continuous variable
NonSchSpt	Student's non-school sports participation, a new composite & dummy variable (0 = participated in non-school sports never/rarely or less than once a week, 1 = participated in non-school sports once/twice a week or almost every day)

Table 4

Details of Variables Used in Three Models (Continued)

Variable Name	Description
Family-related control variables (Family environment)	
FamSES	Family SES, a composite & continuous variable
SglPar	Family structure, a composite & dummy variable (0 = two-parent, 1 = single-parent)
OthPar	Family structure, a composite & dummy variable (0 = two-parent, 1 = other-parent/independent teen)
MedParExp	Parent's expectation for a child's education, a dummy variable (0 = low parental expectation, 1 = medium parental expectation)
HgParExp	Parent's expectation for a child's education, a dummy variable (0 = low parental expectation, 1 = high parental expectation)
School-level control variables (School environment)	
Private	School type, a dummy variable (0 = public, 1 = private)
SmSchSize	School size, a dummy variable (0 = medium school size, 1 = small school size)
LgSchSize	School size, a dummy variable (0 = medium school size, 1 = large school size)
VeLgSchSize	School size, a dummy variable (0 = medium school size, 1 = very large school size)
Suburban	School urbanicity, a dummy variable (0 = urban, 1 = suburban)
Rural	School urbanicity, a dummy variable (0 = urban, 1 = rural/outside MSA)
SchSES	School SES, a new continuous variable
HgMnrStu	School's minority student concentration, a new dummy variable (0 = low minority student concentration, 1 = high minority student concentration)
MedSglPar	School's single-parent student concentration, a dummy variable (0 = low single-parent student concentration, 1= medium single-parent student concentration)
HgSglPar	School's single-parent student concentration, a dummy variable (0 = low single-parent student concentration, 1= high single-parent student concentration)
SchRead	School's reading academic composition, a new continuous variable
SchMath	School's math academic composition, a new continuous variable
SchSci	School's science academic composition, a new continuous variable
SchSwEmSpt	School's emphasis on sports, a dummy variable (0 = not accurate/do not emphasize sports, 1 = somewhat accurate/emphasize sports)
SchVeEmSpt	School's emphasis on sports, a dummy variable (0 = not accurate/do not emphasize sports, 1 = very accurate/emphasize sports)

In each model, the key parameters of interest were γ_{01} through γ_{05} in which each represented the difference in academic achievement growth between students attending schools with a 1-year physical education graduation requirement (reference group) and those attending schools with no physical education course offered or no physical education graduation requirement (γ_{01}), less than 1-year physical education graduation requirement (γ_{02}), 2-year physical education graduation requirement (γ_{03}), 3-year physical education graduation requirement (γ_{04}), or 4-year physical education graduation requirement (γ_{05}), respectively, after controlling for all other student-level (including family-related) and school-level variables.

The overall conceptual model for examining the relationship between physical education graduation requirements and student academic achievement in this study is displayed in Figure 1. The HLM analyses investigate the direct effects of student individual factors on three measures of academic achievement, indicated by an arrow A. The direct effects of family environmental factors on three measures of academic achievement are indicated by an arrow B. The direct effects of school environmental factors on three measures of academic achievement are indicated by an arrow C. The direct effects of physical education graduation requirements on three measures of academic achievement are indicated by an arrow D which is a primary interest of this study.

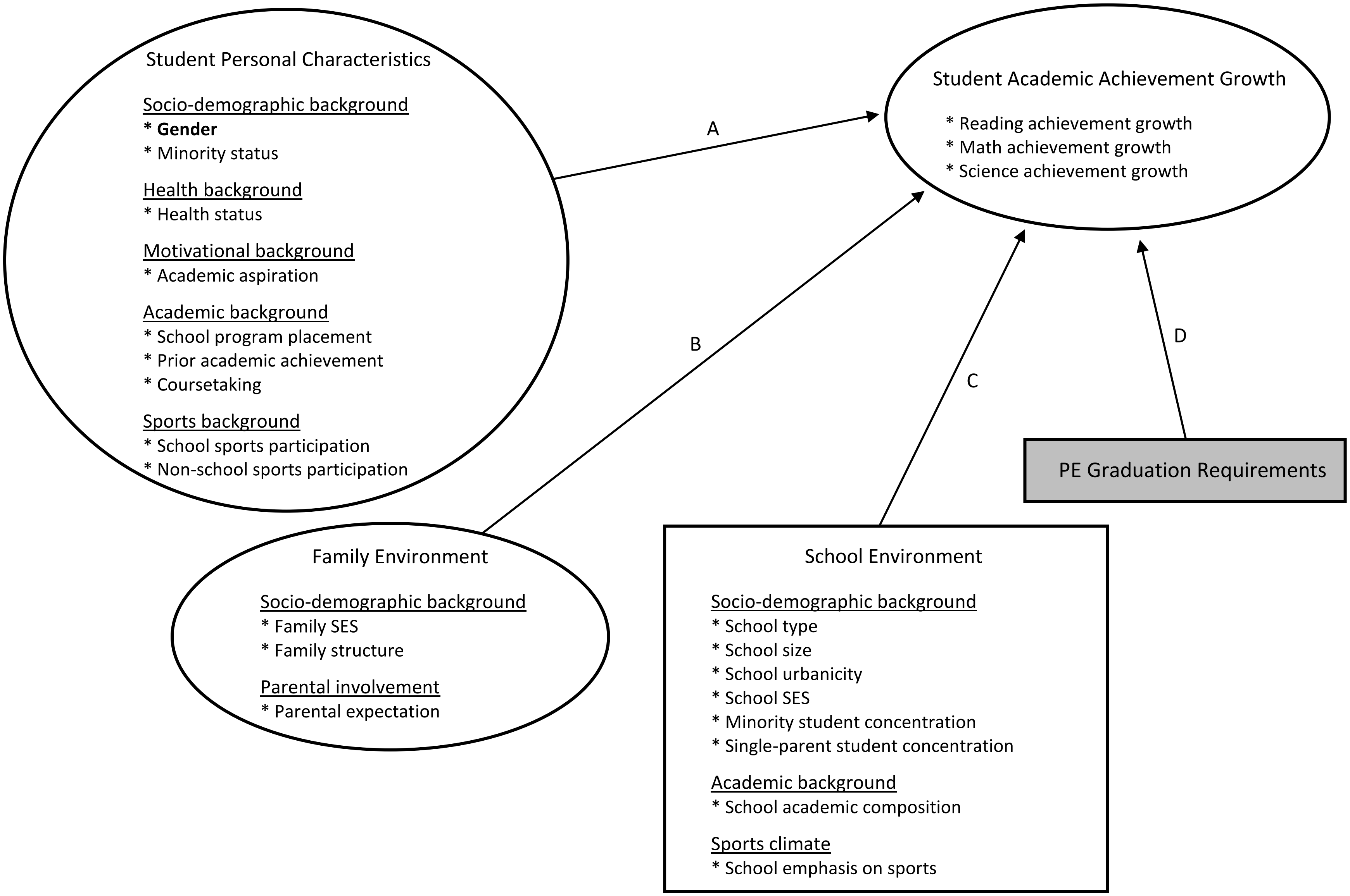

Figure 1. Conceptual model for the relationship between physical education graduation requirements and student academic achievement growth

Chapter 4: Results

This chapter presents the results of the current study. Specifically, it explores the relationship between a school's physical education graduation requirements and students' academic achievement growth in three core subjects (i.e., reading, math, science) from HLM analyses. The chapter consists of five sections. The first section presents the descriptive results from analytic samples. The other four sections present the results from HLM analyses related to four research hypotheses.

Descriptive Analysis

Tables 5 and 6 present descriptive statistics of all variables including dependent variables and control variables used in the analysis by physical education graduation requirements. Given that the analytic samples corresponding to three academic subjects' achievement growth models have few differences in student, family, and school characteristics, descriptive analyses were conducted using the analytic sample for reading achievement growth. Means of continuous variables and percentages of categorical variables were obtained for each of the level-1 variable and level-2 variable. Additionally, mean differences in means and percentages across physical education graduation requirements were tested for statistical significance with pairwise contrasts, having schools with a 1-year physical education graduation requirement as a reference group. Descriptive statistics for student-level (including family-related) characteristics were computed using the normalized student panel weight.

Percentages of students in schools requiring different amount of time in physical education for graduation were quite varied. As shown in Table 5, students attended schools with a 1-year physical education graduation requirement most (33.7%), followed by a 2-year physical education graduation requirement (25.0%), 4-year physical education graduation requirement (22.8%), less than 1-year physical education graduation requirement (10.6%), 3-year physical education graduation requirement (4.6%), and no physical education course offered or no physical education graduation requirement (3.4%). Students attending schools with more than 1-year physical education graduation requirement generally had higher academic achievement growth in reading, mathematics, and science than their counterparts. Particularly, students attending schools with a 3-year physical education graduation requirement displayed significantly higher academic achievement growth in mathematics and science than those attending schools with a 1-year physical education graduation requirement. Similarly, students attending schools with more than 1-year physical education graduation requirement generally had higher prior academic achievement in reading, mathematics, and science than their counterparts. Notably, students attending schools with a 3-year physical education graduation requirement achieved highest in both academic achievement growth and prior academic achievement in reading, mathematics, and science. There was a relatively larger difference in mathematics achievement growth than in reading and science achievement growth across schools by physical education graduation requirements. Additionally, students attending schools with a 1-year physical education graduation requirement generally were more racially/ethnically disadvantaged (i.e., more minority students) and more socioeconomically disadvantaged (i.e., lower family SES) than their counterparts.

As shown in Table 6, the schools requiring 1-year physical education for graduation was most common. This is the same trend observed in recent national reports (e.g., 2012 *Shape of the Nation Report*). School characteristics were associated with physical education graduation requirements. Interestingly, there were large proportions of private schools and small schools requiring 3-year or 4-year physical education for graduation. Also, a large portion of schools with a 3-year or 4-year physical education graduation requirement had higher school socioeconomic composition, lower proportion of minority students enrolled in school, lower proportion of students living with single parents in school, and higher school academic composition than their counterparts.

Given the results of descriptive analyses, it is clear that these descriptive differences in student-level (including family-related) and school-level characteristics are associated with one another and thus simply calculating group mean differences may mislead the relationship between a school's physical education graduation requirements and students' academic achievement. In other words, it indicates that the analyses examining the relation between physical education graduation requirements and student academic achievement should take into account all student, family, and school characteristics by using hierarchical linear modeling analyses.

Table 5

Student-Level Characteristics by Physical Education Graduation Requirements

	NoPE	L1PE	Y1PE	Y2PE	Y3PE	Y4PE
No. of Students	177	559	1,775	1,316	241	1,201
(%)	(3.4)	(10.6)	(33.7)	(25.0)	(4.6)	(22.8)
Dependent variables						
ReadGrowth	5.28	6.02	5.94	6.22	6.38	5.71
MathGrowth	12.67	12.55	12.43	12.83	13.81*	12.78
SciGrowth	3.99	4.89	4.51	4.74	5.23*	4.65
Control variables						
%Female	48.8	53.0	53.7	49.9*	49.1	52.5
%Minority	17.3	14.0*	18.9	19.5	6.4*	10.6*
%Health	6.3	5.3	4.3	4.5	6.2	3.8
%MedAcaAsp	53.4	50.3	49.1	48.9	41.6*	36.3
%HgAcaAsp	28.5	32.0	33.5	37.4*	39.4	36.0
%GenProg	39.6	31.1*	35.8	37.3	34.6	10.6
%OthProg	13.0	15.2	13.4	14.9	12.0	29.5*
PriRead	27.64	28.46	28.19	28.47	30.16*	29.90*
PriMath	35.38*	37.93	37.59	38.72*	41.23*	40.31*
PriSci	19.16	19.66	19.57	19.77	20.93	20.56
UnitRead	4.12	4.00*	4.10	4.09	4.15	4.05
UnitMath	3.17	3.26	3.29	3.27	3.26	3.37*
UnitSci	2.91	3.02	2.97	2.94	3.15*	3.51*
%AdvMath	26.4*	35.3	34.9	37.4	47.5*	44.4*
%Mid2Math	43.9*	31.8	31.3	29.2	24.5*	26.0*
%Mid1Math	21.1	23.6	22.6	26.9*	20.2	21.7
%AdvSci	62.3	62.4	62.1	62.2	70.5*	74.0*
%MedSci	35.2	33.0	34.8	34.2	28.5*	22.9*
SchSpt	1.04	0.92	0.93	0.98	1.19*	1.08*
%NonSchSpt	25.0	26.9	26.7	31.0*	24.0	29.5
FamSES	0.12	0.10	0.04	0.20*	0.32*	0.22*
%SglPar	21.4	15.5	18.1	19.2	15.0	14.8*
%OthPar	13.4	11.6*	16.5	12.6*	9.5*	11.2*
%MedParExp	47.3	45.1	48.9	47.0	41.7	45.0
%HgParExp	41.4	41.5	38.9	42.5	42.4*	45.6*

Note.
1. Total 6,274 students
2. * indicates that a particular percentage or mean is significantly different from that of the reference group at $\alpha = 0.05$.

Table 6

School-Level Characteristics by Physical Education Graduation Requirements

	NoPE	L1PE	Y1PE	Y2PE	Y3PE	Y4PE
No. of Schools	24	65	204	188	32	140
(%)	(3.7)	(10.0)	(31.2)	(28.8)	(4.9)	(21.4)
Control variables						
% Private	25.0	7.7	11.3	11.7	31.3*	24.3*
% SmSchSize	37.5	23.1	23.0	21.3	43.8*	27.9
% LgSchSize	12.5	15.4	17.6	23.4	12.5	9.3*
% VeLgSchSize	0	7.7	2.9	8.0*	3.1	5.0
% Suburban	37.5	27.7	33.3	38.3	46.9	47.9*
% Rural	45.8	41.5	37.7	27.1*	28.1	25.0*
SchSES	0.24	0.01	0.04	0.09	0.37*	0.27*
% HgMnrStu	16.7	16.9	21.1	28.2	6.3*	14.3
% MedSglPar	29.2	53.8	51.5	42.0	28.1*	40.0
% HgSglPar	8.3	7.7	7.8	10.6	6.3	9.3
SchRead	28.17	27.31	27.42	27.24	29.85*	29.67*
SchMath	36.77	36.80	36.48	37.24	41.07*	40.02*
SchSci	19.44	18.92	19.03	19.01	20.45*	20.12*
% SchSwEmSpt	54.2	63.1	55.9	58.0	40.6	52.9
% SchVeEmSpt	37.5	27.7	33.3	33.0	31.3	32.9

Note.
1. Total 653 schools.
2. * indicates that a particular percentage or mean is significantly different from that of the reference group at $\alpha = 0.05$.

Hypothesis 1: Relationship between Physical Education Graduation Requirements and Student Reading Achievement Growth

The first research hypothesis focuses on the relation between a school's physical education graduation requirements and students' academic achievement growth in reading.

> Hypothesis 1: Students who attend schools with more physical education graduation requirements are likely to have higher academic achievement growth in reading than those who attend schools with less or no physical education graduation requirements.

Fully Unconditional Model

Table 7 presents the parameter estimates for random effects, significance, and ICC for reading achievement growth. The random effect, which is a variance component of the intercept at the school level, was significantly different from zero ($p < 0.001$). This result indicated that students' reading achievement growth significantly varied between schools. Specifically, 5% of the total variance in students' reading achievement growth was explained by the variance between schools, supporting the use of multilevel modeling.

Table 7

Fully Unconditional Model for Reading Achievement Growth

Fixed Effect	*b*	*SE*	*t*	*p*	
Intercept	5.98	0.12	51.72	< 0.001	
Random Effect	σ^2	*df*	χ^2	*p*	ICC
Intercept	1.98	652	957.69	< 0.001	0.05
Level 1	43.94				

Hierarchical Linear Model: Student Level (Level 1)

Table 8 presents the parameter estimates for two-level HLM for reading achievement growth. Most student-level (including family-related) variables had statistically significant relations to students' reading achievement growth after controlling for the other student-level variables. Among socio-demographic background variables, students' gender was significantly associated with reading achievement growth. Female students had higher reading achievement growth than male students by 0.48 points. Additionally, students' minority status was significantly linked to reading achievement growth. Minority students had lower reading achievement growth than White or Asian students by 2.42 points. There was no significant relation between students' health status and reading achievement growth once the other student-level variables were taken into account.

All the students' academic background variables had significant relations to reading achievement growth after adjusting for the other student-level variables. Students' academic aspiration was significantly positively associated with reading achievement growth. Students who had medium and high academic aspiration displayed higher reading achievement growth than those who had low academic aspiration by 1.11 points and 2.32 points, respectively. Additionally, students' school program placement was significantly linked to reading achievement growth. Students who were placed in general high school and other program had lower reading achievement growth than those who were placed in academic program by 1.45 points and 2.28 points, respectively. It is worth noting that students' prior academic achievement in reading was significantly negatively related to reading achievement growth. This result indicated that students who had high prior reading achievement showed a lower growth rate of reading achievement than those who had low prior reading achievement. A one-point increase in students' prior reading achievement was related to a 0.33-point decrease in reading achievement growth. Further, students' coursetaking (i.e., total Carnegie units) in reading was significantly positively associated with reading achievement growth. A one-unit increase in students' total Carnegie units earned in reading was associated with a 0.40-point increase in reading achievement growth.

It is interesting to note that students' school sports participation was significantly negatively related to reading achievement growth, holding the other student-level variables constant. As students participated in one more school sport, their reading achievement growth decreased by 0.52 points. No significant association was found between students' non-school sports participation and reading achievement growth once the other student-level variables were taken into account.

All the students' family-related variables had significant relations to reading achievement growth after controlling for the other student-level variables. Family SES was significantly positively associated with reading achievement growth. A one-unit increase in family SES was associated with a 0.50-point increase in reading achievement growth. Additionally, family structure was significantly linked to reading achievement growth. Students who live in single-parent and other-parent family had lower reading achievement growth than those who live in two-parent family by 0.56 points and 0.59 points, respectively. Lastly, parents' expectation for a child's education was significantly positively related to reading achievement growth. Students whose parents had medium and high educational expectation displayed higher reading achievement growth than those whose parents had low educational expectation by 1.38 points and 1.91 points, respectively.

Hierarchical Linear Model: School Level (Level 2)

When compared to student-level (including family-related) variables, only one school-level variable had a statistically significant relation to students' reading achievement growth after controlling for all student-level variables and the other school-level variables. School size was significantly positively associated with reading achievement growth. Students in very large-size schools had higher reading achievement growth than those in middle-size schools by 1.13 points, whereas no significant difference was found in reading achievement growth between students in small-size or large-size schools and those in middle-size schools. Lastly, unlike in mathematics and science, there was no significant link between physical education graduation requirements and student reading achievement growth, which is the focus of this study, once all student-level variables and the other school-level variables were taken into account.

Table 8

Hierarchical Linear Model for Reading Achievement Growth

	b	*SE*	*t*	*p*
Intercept	**6.48****	0.47	13.92	< 0.001
Level 1 fixed effects				
Female (γ10)	**0.48***	0.21	2.24	0.025
Minority (γ20)	**-2.42****	0.33	-7.25	< 0.001
Health (γ30)	-0.70	0.46	-1.53	0.126
MedAcaAsp (γ40)	**1.11****	0.33	3.40	0.001
HgAcaAsp (γ50)	**2.32****	0.36	6.39	< 0.001
GenProg (γ60)	**-1.45****	0.23	-6.37	< 0.001
OthProg (γ70)	**-2.28****	0.32	-7.06	< 0.001
PriRead (γ80)	**-0.33****	0.01	-22.56	< 0.001
UnitRead (γ90)	**0.40****	0.15	2.69	0.007
SchSpt (γ100)	**-0.52****	0.09	-6.12	< 0.001
NonSchSpt (γ110)	< 0.01	0.23	0.02	0.988
FamSES (γ120)	**0.50****	0.16	3.14	0.002
SglPar (γ130)	**-0.56***	0.24	-2.38	0.018
OthPar (γ140)	**-0.59***	0.27	-2.19	0.028
MedParExp (γ150)	**1.38****	0.38	3.61	0.001
HgParExp (γ160)	**1.91****	0.43	4.44	< 0.001
Level 2 fixed effects				
NoPE (γ01)	-0.66	0.44	-1.49	0.135
L1PE (γ02)	0.02	0.39	0.06	0.955
Y2PE (γ03)	0.09	0.28	0.31	0.753
Y3PE (γ04)	0.56	0.66	0.84	0.401
Y4PE (γ05)	-0.10	0.31	-0.34	0.735
Private (γ06)	0.05	0.49	0.11	0.913
SmSchSize (γ07)	0.03	0.29	0.10	0.920
LgSchSize (γ08)	0.29	0.32	0.90	0.370
VeLgSchSize (γ09)	**1.13****	0.43	2.63	0.009
Suburban (γ010)	-0.36	0.32	-1.13	0.260
Rural (γ011)	-0.49	0.35	-1.41	0.160
SchSES (γ012)	0.30	0.37	0.81	0.418
HgMnrStu (γ013)	0.20	0.38	0.52	0.602
MedSglPar (γ014)	0.07	0.24	0.28	0.783
HgSglPar (γ015)	-0.16	0.44	-0.36	0.717
SchRead (γ016)	0.03	0.05	0.62	0.538
SchSwEmSpt (γ017)	-0.36	0.36	-1.00	0.318
SchVeEmSpt (γ018)	-0.29	0.38	-0.75	0.451
Variance components for random effects				
	σ^2	*df*	χ^2	*p*
Intercept	1.91	634	969.11**	< 0.001
Level 1	37.56			

Note.
1. Unweighted n = 6,274 students in reading; unweighted n = 653 schools
2. * $p < 0.05$; ** $p < 0.01$

Hypothesis 2: Relationship between Physical Education Graduation Requirements and Student Mathematics Achievement Growth

The second research hypothesis focuses on the relation between a school's physical education graduation requirements and students' academic achievement growth in mathematics.

Hypothesis 2: Students who attend schools with more physical education graduation requirements are likely to have higher academic achievement growth in mathematics than those who attend schools with less or no physical education graduation requirements.

Fully Unconditional Model

Table 9 presents the parameter estimates for random effects, significance, and ICC for mathematics achievement growth. The random effect, which is a variance component of the intercept at the school level, was significantly different from zero ($p < 0.001$). This result indicated that students' mathematics achievement growth significantly varied between schools. Specifically, 10% of the total variance in students' mathematics achievement growth was explained by the variance between schools, supporting the use of multilevel modeling.

Table 9

Fully Unconditional Model for Mathematics Achievement Growth

Fixed Effect	*b*	*SE*	*t*	*p*	
Intercept	12.68	0.16	80.61	< 0.001	
Random Effect	σ^2	*df*	χ^2	*p*	ICC
Intercept	5.84	652	1,413.42	< 0.001	0.10
Level 1	52.48				

Hierarchical Linear Model: Student Level (Level 1)

Table 10 presents the parameter estimates for two-level HLM for students' academic achievement growth in mathematics. Most student-level (including family-related) variables had statistically significant relations to students' mathematics achievement growth after controlling for the other student-level variables. Among socio-demographic background variables, students' gender was significantly associated with mathematics achievement growth. Female students had lower mathematics achievement growth than male students by 1.52 points. Also, students' minority status was significantly linked to mathematics achievement growth. Minority students had lower mathematics achievement growth than White or Asian students by 2.03 points. There was no significant relation between students' health status and mathematics achievement growth once the other student-level variables were taken into account.

All the students' academic background variables had significant relations to mathematics achievement growth after adjusting for the other student-level variables. Students' academic aspiration was significantly positively associated with mathematics achievement growth. Students who had medium and high academic aspiration displayed higher mathematics achievement growth than those who had low academic aspiration by 0.74 points and 1.63 points, respectively. Additionally, students' school program placement was significantly linked to mathematics achievement growth. Students who were placed in general high school and other program had lower mathematics achievement growth than those who were placed in academic program by 0.77 points and 1.61 points, respectively. It is worth noting that students' prior academic achievement in mathematics was significantly negatively related to mathematics achievement growth. This result indicated that students who had high prior mathematics achievement showed a lower growth rate of mathematics achievement than those who had low prior mathematics achievement. A one-point increase in students' prior mathematics achievement was related to a 0.32-point decrease in mathematics achievement growth. Further, students' coursetaking (i.e., total Carnegie units, course level) in mathematics was significantly positively associated with mathematics achievement growth. Specifically, a one-unit increase in students' total Carnegie units earned in mathematics was associated with a 1.10-point increase in mathematics achievement growth. As the more difficult mathematics courses were taken, higher mathematics achievement growth occurred. Students who took middle-level 1 mathematics, middle-level 2 mathematics, and advanced-level mathematics course had higher mathematics achievement growth than those who took no mathematics or low-level mathematics course by 3.97 points, 7.57 points, and 10.24 points, respectively.

Of interest is that students' school sports participation was significantly negatively related to mathematics achievement growth, holding the other student-level variables constant. As students participated in one more school sport, their mathematics achievement growth decreased by 0.44 points. No significant association was found between students' non-school sports participation and mathematics achievement growth once the other student-level variables were taken into account.

Some students' family-related variables had significant relations to mathematics achievement growth after controlling for the other student-level variables. Family structure was significantly associated with mathematics achievement growth. Students who live in other-parent family had lower mathematics achievement growth than those who live in two-parent family by 0.79 points, whereas no significant difference was found in mathematics achievement growth between students in single-parent family and those in two-parent family. Additionally, parents' expectation for a child's education was significantly positively linked to mathematics achievement growth. Students whose parents had medium and high educational expectation displayed higher mathematics achievement growth than those whose parents had low educational expectation by 0.82 points and 1.15 points, respectively. Lastly, there was no significant relation between family SES and mathematics achievement growth once the other student-level variables were taken into account.

Hierarchical Linear Model: School Level (Level 2)

When compared to student-level (including family-related) variables, only three school-level variables had statistically significant relations to students' mathematics achievement growth after controlling for all student-level variables and the other school-level variables. School size was significantly associated with mathematics achievement growth. Students in small-size and very large-size schools had higher mathematics achievement growth than those in middle-size schools by 0.76 points and 3.10 points, respectively, whereas no significant difference was found in mathematics achievement growth between students in large-size schools and those in middle-size schools. Additionally, schools' single-parent student concentration was significantly positively linked to mathematics achievement growth. Students in schools with high single-parent student concentration had higher mathematics achievement growth than those in schools with low single-parent student concentration by 1.41 points, whereas no significant difference was found in mathematics achievement growth between students in schools with medium single-parent student concentration and those in schools with low single-parent student concentration. Lastly and most importantly, unlike in reading, physical education graduation requirements were significantly related to student mathematics achievement growth, which is the focus of this study, even after adjusting for all student-level variables and the other school-level variables. Students who attend schools with a 3-year physical education graduation requirement had higher mathematics achievement growth than those who attend schools with a 1-year physical education graduation requirement by 1.04 points. However, no significant difference was found in mathematics achievement growth between students in schools with no physical education course offered or no physical education graduation requirement, less than 1-year, 2-year, or 4-year physical education graduation requirement and those in schools with a 1-year physical education graduation requirement once all student-level variables and the other school-level variables were taken into account.

Table 10

Hierarchical Linear Model for Mathematics Achievement Growth

	b	*SE*	*t*	*p*
Intercept	**12.21****	0.51	24.10	< 0.001
Level 1 fixed effects				
Female (γ10)	**-1.52****	0.20	-7.45	< 0.001
Minority (γ20)	**-2.03****	0.40	-5.10	< 0.001
Health (γ30)	-0.39	0.54	-0.72	0.472
MedAcaAsp (γ40)	**0.74***	0.36	2.04	0.041
HgAcaAsp (γ50)	**1.63****	0.40	4.03	< 0.001
GenProg (γ60)	**-0.77****	0.24	-3.21	0.002
OthProg (γ70)	**-1.61****	0.34	-4.72	< 0.001
PriMath (γ80)	**-0.32****	0.01	-27.33	< 0.001
UnitMath (γ90)	**1.10****	0.16	6.70	< 0.001
AdvMath (γ100)	**10.24****	0.65	15.77	< 0.001
Mid2Math (γ110)	**7.57****	0.56	13.64	< 0.001
Mid1Math (γ120)	**3.97****	0.50	8.00	< 0.001
SchSpt (γ130)	**-0.44****	0.08	-5.31	< 0.001
NonSchSpt (γ140)	0.32	0.23	1.40	0.162
FamSES (γ150)	0.34	0.19	1.81	0.070
SglPar (γ160)	-0.25	0.28	-0.90	0.369
OthPar (γ170)	**-0.79****	0.29	-2.76	0.006
MedParExp (γ180)	**0.82***	0.37	2.22	0.026
HgParExp (γ190)	**1.15****	0.38	3.01	0.003
Level 2 fixed effects				
NoPE (γ01)	-0.77	0.74	-1.05	0.294
L1PE (γ02)	0.05	0.51	0.099	0.921
Y2PE (γ03)	0.14	0.33	0.431	0.666
Y3PE (γ04)	**1.04***	0.51	2.022	0.043
Y4PE (γ05)	0.31	0.35	0.888	0.375
Private (γ06)	0.24	0.59	0.405	0.686
SmSchSize (γ07)	**0.76***	0.33	2.324	0.020
LgSchSize (γ08)	0.53	0.38	1.387	0.166
VeLgSchSize (γ09)	**3.10****	0.74	4.206	< 0.001
Suburban (γ010)	0.40	0.39	1.034	0.302
Rural (γ011)	0.35	0.43	0.805	0.421
SchSES (γ012)	0.74	0.50	1.475	0.141
HgMnrStu (γ013)	-0.89	0.51	-1.733	0.083
MedSglPar (γ014)	-0.38	0.27	-1.382	0.167
HgSglPar (γ015)	**1.41***	0.55	2.569	0.011
SchMath (γ016)	< 0.01	0.03	-0.129	0.898
SchSwEmSpt (γ017)	0.06	0.44	0.133	0.895
SchVeEmSpt (γ018)	-0.07	0.45	-0.164	0.871
Variance components for random effects				
	σ^2	*df*	χ^2	*p*
Intercept	4.05	634	1330.08	< 0.001
Level 1	38.11			

Note.
1. Unweighted n = 6,282 students in math; unweighted n = 653 schools
2. * $p < 0.05$; ** $p < 0.01$

Hypothesis 3: Relationship between Physical Education Graduation Requirements and Student Science Achievement Growth

The third research hypothesis focuses on the relation between a school's physical education graduation requirements and students' academic achievement growth in science.

> Hypothesis 3: Students who attend schools with more physical education graduation requirements are likely to have higher academic achievement growth in science than those who attend schools with less or no physical education graduation requirements.

Fully Unconditional Model

Table 11 presents the parameter estimates for random effects, significance, and ICC for science achievement growth. The random effect, which is a variance component of the intercept at the school level, was significantly different from zero ($p < 0.001$). This result indicated that students' science achievement growth significantly varied between schools. Specifically, 8% of the total variance in students' science achievement growth was explained by the variance between schools, supporting the use of multilevel modeling.

Table 11

Fully Unconditional Model for Science Achievement Growth

Fixed Effect	*b*	*SE*	*t*	*p*	
Intercept	4.65	0.09	52.38	< .001	
Random Effect	σ^2	*df*	χ^2	*p*	ICC
Intercept	1.53	652	1,251.78	< .001	0.08
Level 1	17.68				

Hierarchical Linear Model: Student Level (Level 1)

Table 12 presents the parameter estimates for two-level HLM for students' academic achievement growth in science. Most student-level (including family-related) variables had statistically significant relations to students' science achievement growth after controlling for the other student-level variables. Among socio-demographic background variables, students' gender was significantly associated with science achievement growth. Female students had lower science achievement growth than male students by 1.49 points. Also, students' minority status was significantly linked to science achievement growth. Minority students had lower science achievement growth than White or Asian students by 1.92 points. There was no significant relation between students' health status and science achievement growth once the other student-level variables were taken into account.

All the students' academic background variables had significant relations to science achievement growth after adjusting for the other student-level variables. Students' academic aspiration was significantly positively associated with science achievement growth. Students who had high academic aspiration displayed higher science achievement growth than those who had low academic aspiration by 0.63 points, whereas no significant difference was found in science achievement growth between students with medium academic aspiration and those with low academic aspiration. Additionally, students' school program placement was significantly linked to science achievement growth. Students who were placed in general high school and other program had lower science achievement growth than those who were placed in academic program by 0.85 points and 0.69 points, respectively. Notably, students' prior academic achievement in science was significantly negatively related to science achievement growth. This result indicated that students who had high prior science achievement showed a lower growth rate of science achievement than those who had low prior science achievement. A one-point increase in students' prior science achievement was related to a 0.39-point decrease in science achievement growth. Further, students' coursetaking (i.e., total Carnegie units, course level) in science was significantly positively associated with science achievement growth. Specifically, a one-unit increase in students' total Carnegie units earned in science was associated with a 0.65-point increase in science achievement growth. As the more difficult science courses were taken, higher science achievement growth occurred. Students who took middle-level science and advanced-level science course had higher science achievement growth than those who took no science or low-level science course by 0.75 points and 1.98 points, respectively.

Interestingly, students' school sports participation was significantly negatively related to science achievement growth, holding the other student-level variables constant. As students participated in one more school sport, their science achievement growth decreased by 0.22 points. Additionally, students' non-school sports participation was significantly associated with science achievement growth. Students who participated in non-school sports more frequently had lower science achievement growth than those who did not or less frequently participate in non-school sports by 0.30 points.

All the students' family-related variables had significant relations to science achievement growth after controlling for the other student-level variables. Family SES was significantly positively associated with science achievement growth. A one-unit increase in family SES was associated with a 0.29-point increase in reading achievement growth. Additionally, family structure was significantly linked to science achievement growth. Students who live in other-parent family had lower science achievement growth than those who live in two-parent family by 0.42 points, whereas no significant difference was in science achievement growth between students in single-parent family and those in two-parent family. Lastly, parents' expectation for a child's education was significantly positively related to science achievement growth. Students whose parents had medium and high educational expectation had higher science achievement growth than those whose parents had low educational expectation by 0.46 points and 0.76 points, respectively.

Hierarchical Linear Model: School Level (Level 2)

When compared to student-level (including family-related) variables, only three school-level variables had statistically significant relations to students' science achievement growth after controlling for all student-level variables and the other school-level variables. School size was significantly associated with science achievement growth. Students in small-size schools had higher science achievement growth than those in middle-size schools by 0.42 points, whereas no significant difference was found in science achievement growth between students in large-size or very large-size schools and those in middle-size schools. Additionally, school SES was significantly positively linked to science achievement growth. A one-unit increase in school SES was linked to a 0.99-point increase in science achievement growth. Lastly and most importantly, unlike in reading, physical education graduation requirements were significantly related to student science achievement growth, which is the focus of this study, even after adjusting for all student-level variables and the other school-level variables. Students who attend schools with no physical education course offered or no physical education graduation requirement had lower science achievement growth than those who attend schools with a 1-year physical education graduation requirement by 0.82 points. However, no significant difference was found in science achievement growth between students in schools with less than 1-year, 2-year, 3-year, or 4-year physical education graduation requirement and those in schools with a 1-year physical education graduation requirement once all student-level variables and the other school-level variables were taken into account.

Table 12

Hierarchical Linear Model for Science Achievement Growth

	b	*SE*	*t*	*p*
Intercept	**4.79****	0.32	14.78	< 0.001
Level 1 fixed effects				
Female (γ10)	**-1.49****	0.12	-12.61	< 0.001
Minority (γ20)	**-1.92****	0.22	-8.71	< 0.001
Health (γ30)	0.02	0.30	0.06	0.956
MedAcaAsp (γ40)	0.23	0.20	1.16	0.247
HgAcaAsp (γ50)	**0.63****	0.22	2.82	0.005
GenProg (γ60)	**-0.85****	0.16	-5.26	< 0.001
OthProg (γ70)	**-0.69****	0.23	-3.05	0.003
PriSci (γ80)	**-0.39****	0.02	-23.07	< 0.001
UnitSci (γ90)	**0.65****	0.09	7.39	< 0.001
AdvSci (γ100)	**1.98****	0.42	4.69	< 0.001
MidSci (γ110)	**0.75***	0.38	1.98	0.048
SchSpt (γ120)	**-0.22****	0.05	-4.14	< 0.001
NonSchSpt (γ130)	**-0.30***	0.14	-2.17	0.030
FamSES (γ140)	**0.29***	0.11	2.59	0.010
SglPar (γ150)	-0.15	0.16	-0.92	0.360
OthPar (γ160)	**-0.42***	0.21	-1.99	0.046
MedParExp (γ170)	**0.46***	0.20	2.28	0.023
HgParExp (γ180)	**0.76****	0.22	3.52	0.001
Level 2 fixed effects				
NoPE (γ01)	**-0.82****	0.29	-2.80	0.006
L1PE (γ02)	0.19	0.26	0.74	0.461
Y2PE (γ03)	- 0.01	0.18	-0.04	0.972
Y3PE (γ04)	0.27	0.33	0.83	0.410
Y4PE (γ05)	-0.36	0.25	-1.45	0.148
Private (γ06)	-0.55	0.32	-1.72	0.085
SmSchSize (γ07)	**0.42***	0.20	2.14	0.033
LgSchSize (γ08)	0.36	0.24	1.55	0.121
VeLgSchSize (γ09)	0.34	0.43	0.79	0.429
Suburban (γ010)	-0.09	0.25	-0.36	0.716
Rural (γ011)	-0.18	0.28	-0.64	0.525
SchSES (γ012)	**0.99****	0.27	3.61	0.001
HgMnrStu (γ013)	-0.28	0.30	-0.92	0.357
MedSglPar (γ014)	-0.27	0.17	-1.57	0.118
HgSglPar (γ015)	0.13	0.33	0.40	0.690
SchSci (γ016)	-0.01	0.06	-0.23	0.815
SchSwEmSpt (γ017)	0.14	0.23	0.59	0.555
SchVeEmSpt (γ018)	0.18	0.23	0.79	0.428
Variance components for random effects				
	σ^2	*df*	χ^2	*p*
Intercept	1.12	634	1162.64	< 0.001
Level 1	14.37			

Note.
1. Unweighted n = 6,249 students in science; unweighted n = 653 schools
2. * $p < 0.05$; ** $p < 0.01$

Hypothesis 4: Gender Difference in the Relationship between Physical Education Graduation Requirements and Student Academic Achievement Growth

The fourth research hypothesis focuses on gender differences in the relations between a school's physical education graduation requirements and students' academic achievement growth in three core subjects (i.e., reading, math, science). For research hypothesis 4, this study estimated previous models (i.e., Models 1 through 3) again with separate male and female student data.

> Hypothesis 4: The relationships between physical education graduation requirements and three measures of student academic achievement are likely to differ by gender.

As shown in Tables 13 through 15, there were several statistically significant gender differences between student-level and school-level coefficients from models with male and female students in reading, mathematics, and science. For some coefficients, both models with male and female students had significant relations to academic achievement growth, but the magnitude of the relation differed between male and female students. For example, male minority students had relatively much lower academic achievement growth than White or Asian male students while female minority students had relatively less lower academic achievement growth than White or Asian female students in all three core subjects. Specifically, the differences in magnitudes of minority status coefficients were 0.87 points for reading, 1.18 points for mathematics, and 0.67 points for science. For other coefficients, either model with male or female students had significant associations to academic achievement growth, indicating that the statistical significance of the association differed between male and female students. For instance, students' school sports participation was significantly negatively related to science achievement growth among male students, whereas no significant association was found among female students. Conversely, students' non-school sports participation was significantly related to science achievement growth among female students, whereas no significant association was found among male students.

Notably enough, there were significant gender differences in the relations between physical education graduation requirements and student academic achievement growth particularly in mathematics and science even after controlling for all student-level variables and the other school-level variables. Specifically, in mathematics, male students in schools with a 2-year physical education graduation requirement had higher mathematics achievement growth than those in schools with a 1-year physical education graduation requirement by 0.92 points while such significant relation was not found among female students. Instead, female students in schools with a 3-year physical education graduation requirement had higher mathematics achievement growth than those in schools with a 1-year physical education graduation requirement by 1.09 points while such significant association was not found among male students. In science, female students in schools with no physical education course offered or no physical education graduation requirement had lower science achievement growth than those in schools with a 1-year physical education graduation requirement by 0.86 points while such significant relation was not found among male students. Unlike in mathematics and science, there was no significant gender difference in the association between physical education graduation requirements and student reading achievement growth, yielding neither positive nor negative link for both male and female students.

Table 13

Hierarchical Linear Model for Reading Achievement Growth by Gender

	Male				Female			
	b	*SE*	*t*	*p*	*b*	*SE*	*t*	*p*
Intercept	**5.90****	0.67	8.83	< 0.001	**6.94****	0.51	13.50	< 0.001
Level 1 fixed effects								
Minority (γ_{20})	**-2.92****	0.50	-5.84	< 0.001	**-2.05****	0.41	-4.99	< 0.001
Health (γ_{30})	-0.87	0.74	-1.17	0.242	-0.45	0.58	-0.76	0.445
MedAcaAsp (γ_{40})	**1.54****	0.46	3.31	0.001	0.56	0.46	1.22	0.221
HgAcaAsp (γ_{50})	**3.11****	0.53	5.86	< 0.001	**1.47****	0.50	2.95	0.004
GenProg (γ_{60})	**-1.33****	0.35	-3.81	< 0.001	**-1.57****	0.28	-5.61	< 0.001
OthProg (γ_{70})	**-2.39****	0.50	-4.75	< 0.001	**-2.10****	0.41	-5.12	< 0.001
PriRead (γ_{80})	**-0.33****	0.02	-15.28	< 0.001	**-0.33****	0.02	-18.20	< 0.001
UnitRead (γ_{90})	0.24	0.19	1.24	0.215	**0.54****	0.18	3.02	0.003
SchSpt (γ_{100})	**-0.53****	0.12	-4.54	< 0.001	**-0.48****	0.12	-4.04	< 0.001
NonSchSpt (γ_{110})	-0.11	0.29	-0.36	0.720	0.31	0.36	0.88	0.382
FamSES (γ_{120})	0.42	0.26	1.58	0.113	**0.58****	0.21	2.80	0.006
SglPar (γ_{130})	-0.44	0.40	-1.09	0.276	**-0.69***	0.31	-2.20	0.028
OthPar (γ_{140})	-0.46	0.46	-1.02	0.311	-0.62	0.34	-1.80	0.072
MedParExp (γ_{150})	**1.14***	0.54	2.13	0.033	**1.55****	0.53	2.92	0.004
HgParExp (γ_{160})	**1.77****	0.60	2.93	0.004	**1.94****	0.56	3.46	0.001
Level 2 fixed effects								
NoPE (γ_{01})	-0.39	0.65	-0.60	0.548	-0.80	0.49	-1.64	0.101
L1PE (γ_{02})	0.60	0.50	1.20	0.232	-0.46	0.47	-0.97	0.334
Y2PE (γ_{03})	0.55	0.43	1.28	0.203	-0.24	0.31	-0.77	0.444
Y3PE (γ_{04})	0.36	0.82	0.44	0.662	0.75	0.75	1.01	0.315
Y4PE (γ_{05})	-0.33	0.49	-0.67	0.506	0.03	0.31	0.08	0.935
Private (γ_{06})	0.41	0.81	0.51	0.610	-0.10	0.51	-0.20	0.841
SmSchSize (γ_{07})	-0.04	0.40	-0.10	0.920	0.02	0.33	0.05	0.962
LgSchSize (γ_{08})	-0.11	0.57	-0.19	0.852	0.47	0.36	1.32	0.189
VeLgSchSize (γ_{09})	1.11	0.65	1.71	0.087	0.81	0.55	1.48	0.138
Suburban (γ_{010})	0.49	0.51	0.96	0.341	**-1.08****	0.34	-3.14	0.002
Rural (γ_{011})	-0.09	0.56	-0.16	0.875	**-0.86***	0.38	-2.30	0.022
SchSES (γ_{012})	0.15	0.53	0.29	0.770	0.48	0.44	1.09	0.277
HgMnrStu (γ_{013})	0.22	0.62	0.35	0.723	0.30	0.40	0.75	0.457
MedSglPar (γ_{014})	0.20	0.38	0.54	0.589	-0.06	0.27	-0.22	0.827
HgSglPar (γ_{015})	-0.46	0.65	-0.70	0.485	0.02	0.46	0.05	0.958
SchRead (γ_{016})	-0.03	0.07	-0.41	0.682	0.08	0.05	1.44	0.149
SchSwEmSpt (γ_{017})	-0.61	0.50	-1.20	0.229	-0.10	0.39	-0.26	0.797
SchVeEmSpt (γ_{018})	-0.58	0.54	-1.06	0.288	-0.01	0.41	-0.02	0.987
Variance components for random effects								
	σ^2	*df*	χ^2	*p*	σ^2	*df*	χ^2	*p*
Intercept	3.38	593	851.93	< 0.001	1.18	599	785.23	< 0.001
Level 1	43.54				31.30			

Note.
1. Unweighted n = 6,274 students in reading; unweighted n = 653 schools
2. * $p < 0.05$; ** $p < 0.01$

Table 14

Hierarchical Linear Model for Mathematics Achievement Growth by Gender

	Male				Female			
	b	*SE*	*t*	*p*	*b*	*SE*	*t*	*p*
Intercept	**12.54****	0.69	18.08	< 0.001	**11.92****	0.60	19.85	< 0.001
Level 1 fixed effects								
Minority (γ_{20})	**-2.69****	0.57	-4.76	< 0.001	**-1.51****	0.49	-3.10	0.002
Health (γ_{30})	-0.36	0.90	-0.40	0.689	-0.33	0.65	-0.51	0.610
MedAcaAsp (γ_{40})	0.42	0.55	0.77	0.440	**1.02***	0.46	2.19	0.029
HgAcaAsp (γ_{50})	**1.44***	0.59	2.45	0.015	**1.89****	0.55	3.41	0.001
GenProg (γ_{60})	-0.49	0.36	-1.38	0.169	**-1.11****	0.32	-3.44	0.001
OthProg (γ_{70})	**-1.69****	0.56	-3.03	0.003	**-1.56****	0.46	-3.40	0.001
PriMath (γ_{80})	**-0.34****	0.02	-20.82	< 0.001	**-0.30****	0.02	-17.90	< 0.001
UnitMath (γ_{90})	**1.15****	0.23	5.00	< 0.001	**1.17****	0.22	5.39	< 0.001
AdvMath (γ_{100})	**10.20****	0.92	11.03	< 0.001	**9.65****	0.83	11.67	< 0.001
Mid2Math (γ_{110})	**7.43****	0.78	9.57	< 0.001	**7.33****	0.71	10.39	< 0.001
Mid1Math (γ_{120})	**3.75****	0.71	5.29	< 0.001	**3.96****	0.64	6.19	< 0.001
SchSpt (γ_{130})	**-0.52****	0.12	-4.43	< 0.001	**-0.30***	0.13	-2.35	0.019
NonSchSpt (γ_{140})	0.38	0.31	1.22	0.223	0.33	0.33	1.00	0.316
FamSES (γ_{150})	0.20	0.26	0.79	0.433	0.40	0.26	1.57	0.116
SglPar (γ_{160})	-0.45	0.39	-1.16	0.248	-0.20	0.38	-0.52	0.600
OthPar (γ_{170})	-0.69	0.42	-1.65	0.099	-0.78	0.40	-1.96	0.05
MedParExp (γ_{180})	**2.01****	0.51	3.96	< 0.001	-0.64	0.56	-1.13	0.259
HgParExp (γ_{190})	**2.36****	0.55	4.28	< 0.001	-0.40	0.60	-0.65	0.513
Level 2 fixed effects								
NoPE (γ_{01})	-0.33	0.86	-0.39	0.699	-0.94	0.98	-0.96	0.337
L1PE (γ_{02})	0.67	0.68	0.99	0.321	-0.30	0.55	-0.55	0.586
Y2PE (γ_{03})	**0.92***	0.45	2.04	0.042	-0.51	0.37	-1.37	0.171
Y3PE (γ_{04})	0.91	0.73	1.25	0.214	**1.09***	0.54	2.02	0.044
Y4PE (γ_{05})	0.52	0.47	1.11	0.268	0.16	0.40	0.40	0.689
Private (γ_{06})	1.10	0.79	1.38	0.168	-0.76	0.57	-1.33	0.183
SmSchSize (γ_{07})	0.37	0.44	0.84	0.399	**1.10****	0.36	3.03	0.003
LgSchSize (γ_{08})	0.27	0.55	0.50	0.621	0.68	0.41	1.67	0.095
VeLgSchSize (γ_{09})	**3.87****	1.02	3.78	< 0.001	**1.89****	0.70	2.70	0.008
Suburban (γ_{010})	0.70	0.51	1.37	0.171	0.06	0.45	0.13	0.894
Rural (γ_{011})	0.80	0.55	1.47	0.143	-0.09	0.51	-0.17	0.863
SchSES (γ_{012})	0.80	0.67	1.19	0.237	0.84	0.58	1.43	0.153
HgMnrStu (γ_{013})	-0.72	0.68	-1.07	0.286	-0.84	0.58	-1.45	0.147
MedSglPar (γ_{014})	-0.46	0.38	-1.24	0.217	-0.23	0.30	-0.77	0.440
HgSglPar (γ_{015})	0.95	0.67	1.41	0.158	**1.63***	0.67	2.41	0.016
SchMath (γ_{016})	< 0.01	0.05	-0.08	0.936	< 0.01	0.04	-0.03	0.978
SchSwEmSpt (γ_{017})	-0.46	0.65	-0.70	0.482	0.48	0.46	1.06	0.292
SchVeEmSpt (γ_{018})	-0.48	0.66	-0.72	0.472	0.15	0.47	0.32	0.747
Variance components for random effects								
	σ^2	*df*	χ^2	*p*	σ^2	*df*	χ^2	*p*
Intercept	6.10	594	1076.46	< 0.001	3.17	599	931.69	< 0.001
Level 1	39.50				35.56			

Note.
1. Unweighted n = 6,282 students in math; unweighted n = 653 schools;
2. * $p < 0.05$; ** $p < 0.01$

Table 15

Hierarchical Linear Model for Science Achievement Growth by Gender

	Male				Female			
	b	*SE*	*t*	*p*	*b*	*SE*	*t*	*p*
Intercept	**4.75****	0.45	10.66	< 0.001	**4.53****	0.36	12.58	< 0.001
Level 1 fixed effects								
Minority (γ_{20})	**-2.28****	0.35	-6.44	< 0.001	**-1.61****	0.28	-5.68	< 0.001
Health (γ_{30})	-0.04	0.47	-0.09	0.931	0.09	0.38	0.23	0.819
MedAcaAsp (γ_{40})	0.36	0.30	1.19	0.236	0.07	0.26	0.25	0.801
HgAcaAsp (γ_{50})	**0.90****	0.33	2.69	0.008	0.37	0.30	1.22	0.225
GenProg (γ_{60})	**-0.78****	0.21	-3.76	< 0.001	**-0.82****	0.23	-3.51	0.001
OthProg (γ_{70})	**-0.70***	0.30	-2.35	0.019	-0.61	0.32	-1.94	0.052
PriSci (γ_{80})	**-0.44****	0.03	-16.52	< 0.001	**-0.33****	0.02	-15.73	< 0.001
UnitSci (γ_{90})	**0.74****	0.11	6.67	< 0.001	**0.53****	0.12	4.46	< 0.001
AdvSci (γ_{100})	**1.99****	0.64	3.13	0.002	**1.92****	0.50	3.90	< 0.001
MidSci (γ_{110})	0.77	0.56	1.36	0.173	0.78	0.46	1.68	0.093
SchSpt (γ_{120})	**-0.28****	0.07	-3.70	< 0.001	-0.15	0.09	-1.67	0.094
NonSchSpt (γ_{130})	-0.05	0.17	-0.29	0.774	**-0.72****	0.23	-3.12	0.002
FamSES (γ_{140})	0.06	0.16	0.36	0.717	**0.48****	0.14	3.33	0.001
SglPar (γ_{150})	-0.23	0.24	-0.96	0.335	-0.16	0.22	-0.76	0.449
OthPar (γ_{160})	-0.52	0.29	-1.80	0.071	-0.37	0.30	-1.24	0.216
MedParExp (γ_{170})	**0.75***	0.31	2.39	0.017	0.19	0.25	0.77	0.441
HgParExp (γ_{180})	**0.77***	0.34	2.25	0.024	**0.69***	0.28	2.48	0.013
Level 2 fixed effects								
NoPE (γ_{01})	-0.72	0.38	-1.88	0.060	**-0.86***	0.37	-2.32	0.021
L1PE (γ_{02})	0.48	0.33	1.44	0.151	-0.01	0.30	-0.05	0.964
Y2PE (γ_{03})	0.21	0.26	0.80	0.423	-0.15	0.21	-0.70	0.486
Y3PE (γ_{04})	0.08	0.51	0.16	0.872	0.46	0.36	1.26	0.210
Y4PE (γ_{05})	-0.46	0.33	-1.41	0.158	-0.28	0.26	-1.10	0.270
Private (γ_{06})	0.11	0.41	0.27	0.785	**-1.07***	0.38	-2.78	0.006
SmSchSize (γ_{07})	0.32	0.26	1.23	0.221	**0.50***	0.23	2.21	0.028
LgSchSize (γ_{08})	0.35	0.34	1.01	0.313	0.36	0.25	1.45	0.147
VeLgSchSize (γ_{09})	0.76	0.59	1.28	0.202	0.05	0.49	0.10	0.924
Suburban (γ_{010})	0.39	0.34	1.15	0.251	-0.37	0.27	-1.38	0.167
Rural (γ_{011})	0.33	0.37	0.88	0.380	-0.54	0.30	-1.82	0.068
SchSES (γ_{012})	**1.06****	0.36	2.93	0.004	**1.00***	0.32	3.13	0.002
HgMnrStu (γ_{013})	-0.63	0.40	-1.57	0.118	0.04	0.39	0.11	0.914
MedSglPar (γ_{014})	-0.06	0.25	-0.25	0.799	**-0.42***	0.18	-2.33	0.020
HgSglPar (γ_{015})	0.03	0.43	0.06	0.949	0.23	0.38	0.61	0.544
SchSci (γ_{016})	-0.04	0.07	-0.51	0.613	0.00	0.07	0.02	0.986
SchSwEmSpt (γ_{017})	0.07	0.33	0.22	0.828	0.32	0.28	1.15	0.251
SchVeEmSpt (γ_{018})	0.03	0.33	0.09	0.927	0.44	0.27	1.60	0.109
Variance components for random effects								
	σ^2	*df*	χ^2	*p*	σ^2	*df*	χ^2	*p*
Intercept	15.17	594	967.37	< 0.001	0.64	598	781.34	< 0.001
Level 1	1.76				13.38			

Note.
1. Unweighted n = 6,249 students in science; unweighted n = 653 schools
2. * $p < 0.05$; ** $p < 0.01$

Chapter 5: Discussion

Although nationally released recommendations and guidelines have called for schools to play a greater role in enhancing physical activity through physical education, many schools in the U.S. have reduced or eliminated physical education (CDC, 2010c; NASPE & AHA, 2006, 2010, 2012; USDHHS, 2010a). This nationwide school policy on physical education reduction or elimination may be one of the schools' efforts to increase students' academic achievement given the pressured school situation under ongoing educational reforms (e.g., NCLB, CCSS). From a school policy perspective, the assumption of this action is that increasing instructional time in core subjects by decreasing allocated time for physical education would bring improvement of students' academic achievement. However, the consequences of schools' actions hinder the achievement of important physical education goals.

Based on Argyris and Schön's (1974) theory of action, the effectiveness of schools' policies and practices should be tested and evaluated to improve their policies and practices so that schools can provide students with a more effective learning experience and environment. Given this, this study aimed to examine the relation between time requirements of physical education for graduation and student academic achievement in three core high school subjects: reading, mathematics, and science. For this purpose, the study used a multilevel analysis from a large, nationally representative sample of U.S. high schoolers from the NELS database. This chapter summarizes the main findings of this study, followed by educational implications, limitations of the study and suggestions for future research.

Summary of the Main Findings

A major finding of this study was that time requirements of physical education for graduation had either a positive or neutral relationship to students' academic achievement in three core subjects. Specifically, time requirements of physical education for graduation were either positively or neutrally related to student academic achievement growth in mathematics and science while time requirements of physical education for graduation had only a neutral relation to student academic achievement growth in reading, after controlling for student, family, and school characteristics. The findings of this study indicate that certain time requirements of physical education for graduation are positively associated with student academic achievement growth in mathematics and science. The findings of the study further imply that more time requirements schools set aside for physical education for graduation do not decrease student academic achievement growth in reading, mathematics, and science.

Although little research has examined the relation between physical education graduation requirements and academic achievement with high school students, based on the literature on the association between physical education time allocation and academic achievement with elementary (e.g., Ericsson, 2008; Shephard, 1996; Tremarche et al., 2007) and secondary (e.g., Ardoy et al., 2013) students, it was expected that the increased time requirements of physical education would have either a positive or neutral link to academic achievement while not having a negative link. The findings of this study were partly in line with those from Ardoy and colleagues' study (2013) of high school adolescents, indicating a potential positive or neutral relation between allocated time for physical education and student academic achievement in mathematics and science with no compromise of academic achievement. However, it should be cautioned that such a relation might differ by the intensity level of physical activity during physical education classes (e.g., Ardoy et al., 2013) or might be confounded with engagement in other school sports clubs (e.g., Nelson & Gordon-Larsen, 2006).

Although some certain time requirements of physical education for graduation were positively associated with student academic achievement growth in mathematics and science, there was not clear evidence that more time requirements of physical education for graduation were associated with higher student academic achievement growth in mathematics and science. That is, although students in schools with a 3-year physical education graduation requirement had higher mathematics achievement growth than those in schools with a 1-year physical education graduation requirement, such a relation did not exist between students in schools with a 4-year physical education graduation requirement and those in schools with a 1-year physical education graduation requirement. Similarly, although students in schools with no physical education course offered or no physical education graduation requirement had lower science achievement growth than those in schools with a 1-year physical education graduation requirement, students in schools with more than 1-year physical education graduation requirement did not have higher science achievement growth than those in schools with a 1-year physical education graduation requirement.

A plausible explanation for these unclear relations may be partly due to the fact that time requirements of physical education for graduation represent the minimum amount of time participating in physical education. In other words, time requirements of physical education for graduation do *not* represent the *actual* amount of time participating in physical education. Some students are likely to spend more time in physical education than time requirements of physical education for graduation while other students are likely to spend only the minimum amount of physical education time required for graduation. Additionally, different physical education courses might engage students more than others in physical activity. In physical education classes, for instance, Fairclough and Stratton (2005) observed that high school students (N = 122, ages 11–14 years) engaged in most MVPA during team games while they engaged in least MVPA during movement activities. Further, some students within the same classes might be more physically engaged than others during class time. This could influence the results of this study, yielding an unclear relation between time requirements of physical education for graduation and student academic achievement as well as unclear cognitive benefit of physical education on academic achievement. Further, the findings of this study support the literature that has found a positive association between allocated time for physical education and academic achievement among elementary students. These findings suggest that positive relations observed in previous studies with elementary students may *not fully* generalize to high school students.

Furthermore, the findings of this study revealed that there were gender differences in the relations between time requirements of physical education for graduation and student academic achievement growth in certain core subjects (i.e., math, science). Specifically, in mathematics, male students in schools requiring 2-year physical education for graduation had higher mathematics achievement growth than those in schools requiring 1-year physical education for graduation, whereas female students in schools requiring 3-year physical education for graduation had higher mathematics achievement growth than those in schools requiring 1-year physical education for graduation. In science, female students in schools neither offering physical education course nor requiring physical education for graduation had lower science achievement growth than those in schools requiring 1-year physical education for graduation.

A possible explanation for these results may be due to the different levels of physical activity in which male and female students engage particularly during high school years.

Previous research has shown that female adolescent students participated in physical activity less often than male adolescent students (CDC, 2012; Eaton et al., 2012) and had lower intensity of physical activity than male adolescent students during physical education classes (Hannon & Ratliffe, 2005; McKenzie et al., 2000). Specifically, female students are not likely to participate in elective physical education programs because they have negative feelings toward physical education and female students who are not enrolled in physical education are likely to be more physically inactive than those enrolled in physical education (Pate et al., 2007). It is expected, thus, that female students in schools not offering or requiring physical education courses are less likely to attend non-compulsory physical education courses. As a result, high school female students who attend schools neither offering nor requiring physical education may remain physically inactive and this inactivity of female students could be related to lower science achievement growth than high school male students. Another possible reason for these results could be that statistically significant difference in science achievement growth between female students in schools neither offering nor requiring physical education and those in schools requiring 1-year physical education for graduation is spurious. That is, observed association among female students might not be a causal relationship because different levels of causes (i.e., time requirements of physical education for graduation) do not influence the effect (i.e., science achievement growth) in a systematic way (Murnane & Willett, 2011). Given that these results were observed only in science achievement growth but not in reading and mathematics achievement growth, the observed relation between time requirements of physical education for graduation and student academic achievement among female students could *not* be significantly meaningful.

Educational Implications

Given that this study does not provide strong evidence of the positive relation between time requirements of physical education for graduation and student academic achievement growth, there is a limitation of the findings for school policy recommendations for physical education promotion. However, the findings of the study indicate that a school policy of taking time requirements away from physical education and replacing them with core subjects will not necessarily increase student academic achievement growth. Based on Argyris and Schön’s (1974) theory of action, these findings suggest that schools’ current policies and practices of reducing or eliminating physical education time or programs and replacing them with core academic subjects might not be effective because it may not bring about their intended outcomes (i.e., improved student achievement test scores).

It should be noted that schools’ current policies and practices of physical education reduction or elimination may result in unintended consequences. Traditionally, physical education provides a necessary site and opportunity for physical activity aimed at all school-age students to be physically educated or active during the school day. However, the current schools’ policies and practices reduced or eliminated opportunities that school-age students participate in physical activity within school. Given that physically inactive lifestyle (including poor dietary habits) and resulting obesity in children and adolescents are an increasing problem (e.g., Eisenmann, Bartee, & Wang, 2002; Greenleaf & Weiller, 2005; Iannotti & Wang, 2013a; Pearson & Biddle, 2011), schools should help school-age children and adolescents become more engaged in physical activity and encourage them to pursue a physically active and healthy lifestyle through physical education programs. Given that physical education does not engage students in the nationally recommended level of physical activity partly due to the limited allocated time for physical education (e.g., Fairclough &Stratton, 2005; Simons-Morton, Taylor, Snider, Huang, & Fulton, 1994), schools need to expand their roles in enhancing students' health as well as academic performance by increasing the time allocated to physical education. That is, one of the ways in which schools can engage students in more physical activity is through the increased time for physical education courses as a policy requirement for graduation.

Furthermore, schools' current policies and practices of reducing or eliminating physical education time or programs could actually hinder accomplishing important physical education goals such as students' health and lifetime wellness (e.g., Le Masurier & Corbin, 2006; Trudeau & Shephard, 2008). Specifically, physical education is aimed at promoting students' physical fitness, health- or sport-related knowledge, motor skills, and confidence necessary for their active and healthy lifestyles in and out of school (NASPE, 2004, 2009a, 2009b, 2009c, 2013; Pate et al., 2006; SHAPE America, 2013a, 2013c, 2014). These benefits are crucial for students' current school activities (including classroom behaviors and cognitive functioning or academic performance) as well as their future career or lives (e.g., Dwyer et al., 1996; IOM, 2013a; Kohl & Cook, 2013; Raviv & Low, 1990; SHAPE America, 2013a; Siedentop, 2009; Trost, 2007, 2009). Therefore, schools' current policies and practices of reducing or eliminating physical education time or programs, along with mandated graduation requirements, to increase students' academic achievement should be carefully investigated for their effectiveness.

It is important to point out that scientific evidence has continued to support substantial cognitive benefits of physical activity through physical education. Previous research has indicated that physical activity can help improve brain function and (neuro) cognitive performance or development (e.g., Cotman & Berchtold, 2002; Fabel & Kempermann, 2008; Hillman et al., 2014). Given that physical education is a place where all school-age students regularly participate in organized physical activity, physical activity through physical education may help children and adolescents improve their cognitive development or growth even though the findings of this study do *not fully* support this claim. Given the limitations of this study that will be discussed next, further research needs to be conducted to investigate the relationship between physical education requirements and academic achievement with high school students.

Limitations of the Study and Suggestions for Future Research

There are several limitations to be considered when interpreting the findings of this study. First, this study could not include measures related to the quality of physical education (e.g., qualification of teacher, intensity level of physical activity, amount of time in MVPA) in the analysis even though these measures have been reported to be associated with students' academic achievement. Previous research has found that the increased time allocated to physical education is linked to the increased level of physical activity (e.g., Dwyer et al., 1996), but allocated time for physical education may not be an accurate measure of physical activity in which students engage. Similarly, time requirements of physical education for graduation used in this study may be a blunt measure of physical activity. Previous studies have demonstrated the association between physical activity intensity level during physical education and student academic achievement (e.g., Ardoy et al., 2013; Coe et al., 2007; Kwak et al., 2009). That is, students' engaged time in MVPA during physical education classes was also an important factor in examining a potential benefit of physical activity through physical education on academic achievement. Based on the literature, it is likely that participating students in MVPA during physical education classes may have more academic benefits than non-participating students. Similarly, non-participating students in MVPA during physical education classes may be likely to have less or no academic benefits than participating students regardless of the allocated time for physical education. Therefore, the intensity level of physical activity and engaged time in MVPA along with the allocated time for physical education could be more accurate measures of physical activity during physical education classes and all these measures are recommended to use for better examination of the relation between physical education and academic achievement in future research. That is, the quality of physical education as well as quantity of physical education in which students participate should be taken into account when investigating the relationship between physical education and academic achievement. Because this study could not include measures linked to the quality of physical education due to the unavailability of data, future research is recommended to include the measures of quality physical education to better understand the association between physical education and student academic achievement.

Although previous studies have found the positive relation between physical education and students' classroom attitudes or behaviors (e.g., classroom attention, Dwyer et al., 1996), this study only examined the association between physical education graduation requirements and student achievement growth as a single academic measure. Using students' overall educational or academic performance, including school or classroom attitudes and behaviors as well as standardized test scores, would help to better explain the potential academic benefit of physical education. Therefore, future research is encouraged to use various measures of students' academic performance such as classroom attitudes and behaviors to better examine cognitive and academic benefits of physical education.

Another possible limitation is that although the findings of this study support the positive relation between physical education graduation requirements and student academic achievement growth in mathematics and science, the findings do not indicate causation given the nature of the study. It is impossible to determine, thus, whether time requirements of physical education have a causal link to student academic achievement. As Murnane and Willett (2010) suggested, randomized experiments or quasi-experiments can be used to examine the causal relationship between physical education and academic achievement. For example, one might use randomized experiments by randomly assigning students to different groups (e.g., treatment group vs. control group) with different physical education courses. That is, different physical education interventions can be implemented in terms of the allocated time for physical education, intensity level of physical activity during physical education, and engaged time in MVPA during physical education. Then, measuring students' academic achievement and examining the difference across physical education intervention effects could give evidence to make causal inference.

In addition, the current study did not examine the mechanism underlying the association between physical education graduation requirements and student academic achievement growth and hence could not describe the reasons that some relations are positive and other relations are neutral. Further, the current study did *not* investigate *how* physical education graduation requirements are associated with student academic achievement growth. It is not clear in the relevant literature whether physical education is directly or indirectly linked to student academic achievement. Therefore, well-designed experimental research containing potential factors such as various measures of quality and quantity of physical education could go further to better examine the nature of the relationship between physical education and student academic achievement.

From a methodological stance, the multilevel analyses used in this study have some limitations. The study could not fully incorporate the complex sampling design features of the NELS data into the analysis. Specifically, although the NELS data were collected through a two-stage sample selection process (clustering) along with stratification, the study could not take the stratification sampling feature into account in the analysis because the public-use NELS data did not contain stratification information for confidentiality reasons. Also, the NELS data do not contain school weight and thus school data could not be weighted in the analysis. Previous studies have demonstrated, for instance, that the unweighted school data may result in possible biases of standard error estimates (e.g., Kalton, 1983).

Furthermore, another methodological limitation is the inability to generalize the findings of the current study to the nation. Although the full sample in the NELS data was a nationally representative sample of high school students, the analytic sample used in this study was more academically and racially/ethnically advantaged than the full sample. Given that, the findings of this study may not generalize to the nation and, instead, may generalize to high school students who are more academically and racially/ethnically advantaged. Further, the NELS data used in this study are relatively old and, thus, the findings of the study may not generalize to the nation during the current time period. Therefore, future research needs to use more recent data for better examination of the relation between physical education requirements and student academic achievement.

As in this study, future research should also ensure that physical education and health education requirements are disentangled to better understand the relationship. To the best of my knowledge, there is no available recent national dataset where secondary physical education requirements and health education requirements are separate as of the time conducting this dissertation study. Therefore, more recent and independent datasets of physical education requirements may provide more insight and useful guidelines for policymakers, school administrators, physical educators, and other stakeholders which also could enhance the effectiveness of schools' physical education policies and practices.

Lastly, future research could employ state-level data to investigate the association between time requirements of physical education and student academic achievement. It is assumed that the political and environmental factors affecting physical education implementation may differ across states. As indicated in the 2012 *Shape of the Nation Report* (NASPE & AHA, 2012), the amount of time allocated to physical education varies across states. It is also expected that other physical education status such as physical education curriculum and implementation may vary across states. This variation could affect the quality of physical education including students' engaged time in physical education, quality teacher, quality instruction, and quality program or curriculum as well as schools' allocated time requirements of physical education, which is linked to academic benefit of physical activity through physical education (e.g., Coe et al., 2007; Kwak et al., 2009). Given that physical activity level during physical education class time varied across geographical regions (e.g., McKenzie et al., 1995), the relationship between physical education requirements and student academic achievement could differ depending on state-specific political and environmental factors associated with physical education policies and practices. Accordingly, more studies are deemed necessary to examine whether the relation between physical education time allocation and student academic achievement differs across states.

References

Abrams, L. M., Pedulla, J. J., & Madaus, G. F. (2003). Views from the classroom: Teachers' opinions of statewide testing programs. *Theory into Practice, 42*(1), 18–29.

Abu-Hilal, M. M. (2000). A structural model of attitudes towards school subjects, academic aspiration and achievement. *Educational Psychology: An International Journal of Experimental Educational Psychology, 20*(1), 75–84.

Agostino, A., Johnson, J., & Pascual-Leone, J. (2010). Executive functions underlying multiplicative reasoning: Problem type matters. *Journal of Experimental Child Psychology, 105*(4), 286–305.

Ainsworth, B. E., Haskell, W. L., Herrmann, S. D., Meckes, N., Bassett, D. R., Jr., Tudor-Locke, C., Greer, J. L., Vezina, J., Whitt-Glover, M. C., & Leon, A. S. (2011). 2011 Compendium of physical activities: A second update of codes and MET values. *Medicine & Science in Sports & Exercise, 43*(8), 1575–1581.

Ainsworth, B. E., Haskell, W. L., Leon, A. S., Jacobs, D. R., Jr., Montoye, H. J., Sallis, J. F., & Paffenbarger, R. S., Jr. (1993). Compendium of physical activities: Classification of energy costs of human physical activities. *Medicine & Science in Sports & Exercise, 25*(1), 71–80.

Ainsworth, B. E., Haskell, W. L., Whitt-Glover, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., O'Brien, W. L., Bassett, D. R., Jr., Schmitz, K. H., Emplaincourt, P. O., Jacobs, D. R., Jr., & Leon, A. S. (2000). Compendium of physical activities: An update of activity codes and MET intensities. *Medicine & Science in Sports & Exercise, 32*(9, Suppl.), S498–S516.

Andersen, R. E., Crespo, C. J., Bartlett, S. J., Cheskin, L. J., & Pratt, M. (1998). Relationship of physical activity and television watching with body weight and level of fatness among children: Results from the Third National Health and Nutrition Examination Survey. *The Journal of the American Medical Association, 279*(12), 938–942.

Anderson, P. (2002). Assessment and development of executive function (EF) during childhood. *Child Neuropsychology, 8*(2), 71–82.

Anderson, V. A., Anderson, P., Northam, E., Jacobs, R., & Catroppa, C. (2001). Development of executive functions through late childhood and adolescence in an Australian sample. *Developmental Neuropsychology, 20*(1), 385–406.

Ardoy, D. N., Fernández-Rodríguez, J. M., Jiménez-Pavón, D., Castillo, R., Ruiz, J. R., & Ortega, F. B. (2013). A Physical Education trial improves adolescents' cognitive performance and academic achievement: The EDUFIT study. *Scandinavian Journal of Medicine & Science in Sports, 24*(1), e52–e61. doi: 10.1111/sms.12093

Argyris, C. (1980). Some limitations of the case method: Experiences in a management development program. *Academy of Management review, 5*(2), 291–298.

Argyris, C., & Schön, D. A. (1974). *Theory in practice: Increasing professional effectiveness.* San Francisco, CA: Jossey-Bass.

Aryana, M. (2010). Relationship between self-esteem and academic achievement amongst pre-university students. *Journal of Applied Sciences, 10*(20), 2474–2477.

Bailey, R. (2006). Physical education and sport in schools: A review of benefits and outcomes. *Journal of School Health, 76*(8), 397–401.

Bailey, R., Armour, K., Kirk, D., Jess, M., Pickup, I., Sandford, R., & BERA Physical Education and Sport Pedagogy Special Interest Group. (2009). The educational benefits claimed for physical education and school sport: An academic review. *Research Papers in Education, 24*(1), 1–27.

Barber, B. L., Eccles, J. S., & Stone, M. R. (2001). Whatever happened to the jock, the brain, and the princess? Young adult pathways linked to adolescent activity involvement and social identity. *Journal of Adolescent Research, 16*(5), 429–455.

Barnard, W. M. (2004). Parent involvement in elementary school and educational attainment. *Children and Youth Services Review, 26*(1), 39–62.

Basch, C. E. (2011a). Healthier students are better learners: A missing link in school reforms to close the achievement gap. *Journal of School Health, 81*(10), 593–598.

Basch, C. E. (2011b). Physical activity and the achievement gap among urban minority youth. *Journal of School Health, 81*(10), 626–634.

Beddoes, Z., Prusak, K. A., & Hall, A. (2014). Overcoming marginalization of physical education in America's schools with professional learning communities. *Journal of Physical Education, Recreation & Dance, 85*(4), 21–27.

Beets, M. W., Beighle, A., Erwin, H. E., & Huberty, J. L. (2009). After-school program impact on physical activity and fitness: A meta-analysis. *American Journal of Preventive Medicine, 36*(6), 527–537.

Beets, M. W., Huberty, J., & Beighle, A. (2012). Physical activity of children attending afterschool programs: Research- and practice-based implications. *American Journal of Preventive Medicine, 42*(2), 180–184.

Beets, M. W., Wallner, M., & Beighle, A. (2010). Defining standards and policies for promoting physical activity in afterschool programs. *Journal of School Health, 80*(8), 411–417.

Beighle, A., & Moore, M. (2012). Physical activity before and after school. *Journal of Physical Education, Recreation & Dance, 83*(6), 25–28.

Beighle, A., & Morrow, J. R., Jr. (2014). Promoting physical activity: Addressing barriers and moving forward. *Journal of Physical Education, Recreation & Dance, 85*(7), 23–26.

Benveniste, L., Carnoy, M., & Rothstein, R. (2003). *All else equal: Are public and private schools different?* New York, NY: Routledge.

Bentler, P. M., & Speckart, G. (1979). Models of attitude–behavior relations. *Psychological review, 86*(5), 452–464.

Best, J. R. (2010). Effects of physical activity on children's executive function: Contributions of experimental research on aerobic exercise. *Developmental Review, 30*(4), 331–351.

Best, J. R., Miller, P. H., & Naglieri, J. A. (2011). Relations between executive function and academic achievement from ages 5 to 17 in a large, representative national sample. *Learning and Individual Differences, 21*(4), 327–336.

Bierman, K. L., Nix, R. L., Greenberg, M. T., Blair, C, & Domitrovich, C. E. (2008). Executive functions and school readiness intervention: Impact, moderation, and mediation in the Head Start REDI program. *Development and Psychopathology, 20*(3), 821–843.

Blair, C., & Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Development and Psychopathology, 20*(3), 899–911.

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development, 78*(2), 647–663.

Blakemore, S-J., & Choudhury, S. (2006). Development of the adolescent brain: Implications for executive function and social cognition. *Journal of Child Psychology and Psychiatry, 47*(3-4), 296–312.

Bocarro, J. N., Kanters, M. A., Cerin, E., Floyd, M. F., Casper, J. M., Suau, L. J., & McKenzie, T. L. (2012). School sport policy and school-based physical activity environments and their association with observed physical activity in middle school children. *Health & Place, 18*(1), 31–38.

Bong, M., & Skaalvik, E. M. (2003). Academic self-concept and self-efficacy: How different are they really? *Educational Psychology Review, 15*(1), 1–40.

Broh, B. A. (2002). Linking extracurricular programming to academic achievement: Who benefits and why? *Sociology of Education, 75*(1), 69–95.

Brookover, W. B., Erickson, E. L., & Joiner, L. M. (1967). Educational aspirations and educational plans in relation to academic achievement and socioeconomic status. *The School Review, 75*(4), 392–400.

Brosse, A. L., Sheets, E. S., Lett, H. S., & Blumenthal, J. A. (2002). Exercise and the treatment of clinical depression in adults: Recent findings and future directions. *Sports Medicine, 32*(12), 741–760.

Brown, D. R., Heath, G. W., & Martin, S. L. (Eds.). (2010). *Promoting physical activity: A guide for community action* (2nd Ed.). Champaign, IL: Human Kinetics.

Bull, R., Espy, K. A., & Wiebe, S. A. (2008). Short-term memory, working memory, and executive functioning in preschoolers: Longitudinal predictors of mathematical achievement at age 7 years. *Developmental Neuropsychology, 33*(3), 205–228.

Bull, R., & Scerif, G. (2001). Executive functioning as a predictor of children's mathematics ability: Inhibition, switching, and working memory. *Developmental Neuropsychology, 19*(3), 273–293.

Burgeson, C. R., Wechsler, H., Brener, N. D., Young, J. C., & Spain, C. G. (2001). Physical education and activity: Results from the School Health Policies and Programs Study 2000. *Journal of School Health*, *71*(7), 279–293.

Burgeson, C. R., Wechsler, H., Brener, N. D., Young, J. C., & Spain, C. G. (2003). Physical education and activity: Results from the School Health Policies and Programs Study 2000. *Journal of Physical Education, Recreation & Dance*, *74*(1), 20–36.

Burkam, D. T., & Lee, V. E. (2003). *Mathematics, foreign language, and science coursetaking and the NELS:88 transcript data* (NCES 2003–01). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Byrne, B. M. (1984). The general/academic self-concept nomological network: A review of construct validation research. *Review of Educational Research, 54*(3), 427–456.

Byrne, B. M. (1986). Self-concept/academic achievement relations: An investigation of dimensionality, stability, and causality. *Canadian Journal of Behavioural Science, 18*(2), 173–186.

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), 721–727.

Carolan, B. V. (2010). Estimating the effects of students' social networks: Does attending a norm-enforcing school pay off? *The Urban Review, 42*(5), 422–440.

Case, A., & Paxson, C. H. (2006). Children's health and social mobility. *The Future of Children, 16*(2), 151–173.

Casey, M. M., Eime, R. M., Payne, W. R., & Harvey, J. T. (2009). Using a socioecological approach to examine participation in sport and physical activity among rural adolescent girls. *Qualitative Health Research, 19*(7), 881–893.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Reports, 100*(2), 126–131.

Castelli, D. M., Centeio, E. E., Beighle, A. E., Carson, R. L., & Nicksic, H. M. (2014). Physical literacy and comprehensive school physical activity programs. *Preventive Medicine, 66,* 95–100.

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*(2), 239–252.

Caterino, M. C., & Polak, E. D. (1999). Effects of two types of activity on the performance of second-, third-, and fourth-grade students on a test of concentration. *Perceptual and Motor Skills, 89*(1), 245–248.

Centers for Disease Control and Prevention. (2004). Participation in high school physical education: United States, 1991-2003. *Morbidity and Mortality Weekly Report, 53*(36), 844–847.

Centers for Disease Control and Prevention. (2006). Youth Risk Behavior Surveillance – United States, 2005. *Morbidity and Mortality Weekly Report, 55*(SS-5), 1–108.

Centers for Disease Control and Prevention. (2010a). *Promoting physical activity: A guide for community action* (2nd Ed.). Champaign, IL: Human Kinetics.

Centers for Disease Control and Prevention. (2010b). *State indicator report on physical activity, 2010.* Atlanta, GA: U.S. Department of Health and Human Services.

Centers for Disease Control and Prevention. (2010c). *Strategies to improve the quality of physical education.* Atlanta, GA: U.S. Department of Health and Human Services.

Centers for Disease Control and Prevention. (2010d). *The association between school-based physical activity, including physical education, and academic performance.* Atlanta, GA: U.S. Department of Health and Human Services.

Centers for Disease Control and Prevention. (2011a). School health guidelines to promote healthy eating and physical activity. *Morbidity and Mortality Weekly Report, 60*(5), 1–78.

Centers for Disease Control and Prevention. (2011b). *Strategies to prevent obesity and other chronic diseases: The CDC guide to strategies to increase physical activity in the community.* Atlanta, GA: U.S. Department of Health and Human Services.

Centers for Disease Control and Prevention. (2012). Youth Risk Behavior Surveillance – United States, 2011. *Morbidity and Mortality Weekly Report, 61*(SS-4), 1–162.

Centers for Disease Control and Prevention. (2013a). *Comprehensive school physical activity programs: A guide for schools*. Atlanta, GA: U.S. Department of Health and Human Services.

Centers for Disease Control and Prevention. (2013b). *Results from the School Health Policies and Practices Study 2012.* Atlanta, GA: U.S. Department of Health and Human Services.

Centers for Disease Control and Prevention. (2014a). *National framework for physical activity and physical education.* Atlanta, GA: U.S. Department of Health and Human Services.

Centers for Disease Control and Prevention. (2014b). *State indicator report on physical activity, 2014.* Atlanta, GA: U.S. Department of Health and Human Services.

Chaddock, L., Pontifex, M. B., Hillman, C. H., & Kramer, A. F. (2011). A review of the relation of aerobic fitness and physical activity to brain structure and function in children. *Journal of the International Neuropsychological Society, 17*(6), 975–985.

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*(1), 30–37.

Cobb, R. A., McIntire, W. G., & Pratt, P. A. (1989). Vocational and educational aspirations of high school students: A problem for rural America. *Research in Rural Education, 6*(2), 11–16.

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*(8), 1515–1519.

Colabianchi, N., Johnston, L. D., & O’Malley, P. M. (2012). *Sports participation in secondary schools: Resources available and inequalities in participation.* Ann Arbor, MI: Bridging the Gap Program of the Robert Wood Johnson Foundation, Institute for Social Research, University of Michigan.

Colcombe, S. J., Kramer, A. F., Erickson, K. I., Scalf, P., McAuley, E., Cohen, N. J., Webb, A., Jerome, G. J., Marquez, D. X., Elavsky, S., & Greenough, W. T. (2004). Cardiovascular fitness, cortical plasticity, and aging. *National Academy of Sciences*, *101*(9), 3316–3321.

Comer, J. P., & Haynes, N. M. (1991). Parent involvement in schools: An ecological approach. *The Elementary School Journal*, *91*(3), 271–277.

Confrey, J., & Krupa, E. (2010, August). *Curriculum design, development, and implementation in an era of Common Core State Standards.* Report presented at the conference of the Center for the Study of Mathematics Curriculum, Arlington, VA.

Cooper, A. R., Page, A. S., Foster, L. J., & Qahwaji, D. (2003). Commuting to school: Are children who walk more physically active? *American Journal of Preventive Medicine, 25*(4), 273–276.

Cotman, C. W., & Berchtold, N. C. (2002). Exercise: A behavioral intervention to enhance brain health and plasticity. *Trends in Neurosciences*, *25*(6), 295–301.

Crosnoe, R. (2006). Health and the education of children from racial/ethnic minority and immigrant families. *Journal of Health and Social Behavior, 47*(1), 77–93.

Curtin, T. R., Ingels, S. J., Wu, S., & Heuer, R. (2002). *National Education Longitudinal Study of 1988: Base-year to fourth follow-up data file user's manual* (NCES 2002–323). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Daley, A. J. (2002). School based physical activity in the United Kingdom: Can it create physically active adults? *Quest, 54*(1), 21–33.

Daley, A. J., & Ryan, J. (2000). Academic performance and participation in physical activity by secondary school adolescents. *Perceptual and Motor Skills, 91*(2), 531–534.

Danish, S. J., Forneris, T., & Wallace, I. (2005). Sport-based life skills programming in the schools. *Journal of Applied School Psychology, 21*(2), 41–62.

Darling, N. (2005). Participation in extracurricular activities and adolescent adjustment: Cross-sectional and longitudinal findings. *Journal of Youth and Adolescence, 34*(5), 493–505.

Darling, N., Caldwell, L. L., & Smith, R. (2005). Participation in school-based extracurricular activities and adolescent adjustment. *Journal of Leisure Research, 37*(1), 51–76.

Darling-Hammond, L. (2004). Standards, accountability, and school reform. *The Teachers College Record*, *106*(6), 1047–1085.

Davis, C. L., & Cooper, S. (2011). Fitness, fatness, cognition, behavior, and academic achievement among overweight children: Do cross-sectional associations correspond to exercise trial outcomes? *Preventive Medicine*, *52*(Suppl. 1), S65–S69.

Davis, C. L., Tomporowski, P. D., Boyle, C. A., Waller, J. L., Miller, P. H., Naglieri, J. A., & Gregoski, M. (2007). Effects of aerobic exercise on overweight children's cognitive functioning: A randomized controlled trial. *Research Quarterly for Exercise and Sport, 78*(5), 510–519.

Davis, C. L., Tomporowski, P. D., McDowell, J. E., Austin, B. P., Miller, P. H., Yanasak, N. E., Allison, J. D., & Naglieri, J. A. (2011). Exercise improves executive function and achievement and alters brain activation in overweight children: A randomized controlled trial. *Health Psychology, 30*(1), 91–98.

Desimone, L. (1999). Linking parent involvement with student achievement: Do race and income matter? *The Journal of Educational Research*, *93*(1), 11–30.

Diamond, A. (2012). Activities and programs that improve children's executive functions. *Current Directions in Psychological Science, 21*(5), 335–341.

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science, 333*(6045), 959–964.

Dohle, S., & Wansink, B. (2013). Fit in 50 years: Participation in high school sports best predicts one's physical activity after age 70. *BMC Public Health, 13*(1), 1100. doi:10.1186/1471-2458-13-1100

Donnelly, J. E., & Lambourne, K. (2011). Classroom-based physical activity, cognition, and academic achievement. *Preventive Medicine, 52*(Suppl. 1), S36–S42.

Drake, K. M., Longacre, M. R., MacKenzie, T., Titus, L. J., Beach, M. L., Rundle, A. G., & Dalton, M. A. (2014). High school sports programs differentially impact participation by sex. *Journal of Sport and Health Science*. http://dx.doi.org/10.1016/j.jshs.2013.11.006

Dunn, A. L., Trivedi, M. H., & O'Neal, H. A. (2001). Physical activity dose-response effects on outcomes of depression and anxiety. *Medicine & Science in Sports & Exercise, 33*(Suppl. 6), S587–S597.

Dwyer, T., Blizzard, L., & Dean, K. (1996). Physical activity and performance in children. *Nutrition Reviews, 54*(4), S27–S31.

Eaton, D. K., Kann, L., Kinchen, S., Ross, J., Hawkins, J., Harris, W. A., Lowry, R., McManus, T., Chyen, D., Shanklin, S., Lim, C., Grunbaum, J. A., & Wechsler, H. (2006a). Youth Risk Behavior Surveillance–United States, 2005. *Journal of School Health, 76*(7), 353–372.

Eaton, D. K., Kann, L., Kinchen, S., Ross, J., Hawkins, J., Harris, W. A., Lowry, R., McManus, T., Chyen, D., Shanklin, S., Lim, C., Grunbaum, J. A., & Wechsler, H. (2006b). Youth Risk Behavior Surveillance – United States, 2005. *Morbidity and Mortality Weekly Report, 55*(SS-5), 1–108.

Eaton, D. K., Kann, L., Kinchen, S., Shanklin, S., Flint, K. H., Hawkins, J., Harris, W. A., Lowry, R., McManus, T., Chyen, D., Whittle, L., Lim, C., & Wechsler, H. (2012). Youth Risk Behavior Surveillance – United States, 2011. *Morbidity and Mortality Weekly Report, 61*(SS-4), 1–162.

Eisenmann, J. C., Bartee, R. T., & Wang, M. O. (2002). Physical activity, TV viewing, and weight in U.S. youth: 1999 Youth Risk Behavior Survey. *Obesity Research, 10*(5), 379–385.

Eitle, T. M. (2005). Do gender and race matter? Explaining the relationship between sports participation and achievement. *Sociological Spectrum, 25*(2), 177–195.

Elliott, M. (1998). School finance and opportunities to learn: Does money well spent enhance students' achievement? *Sociology of Education, 71*(3), 223–245.

Enders, C. K., & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods, 12*(2), 121–138.

Engberg, M. E., & Wolniak, G. C. (2010). Examining the effects of high school contexts on postsecondary enrollment. *Research in Higher Education, 51*(2), 132–153.

Ericsson, I. (2008). Motor skills, attention and academic achievements: An intervention study in school years 1–3. *British Educational Research Journal, 34*(3), 301–313.

Fabel, K., & Kempermann, G. (2008). Physical activity and the regulation of neurogenesis in the adult and aging brain. *NeuroMolecular Medicine, 10*(2), 59–66.

Fairclough, S., & Stratton, G. (2005). 'Physical education makes you fit and healthy'. Physical education's contribution to young people's physical activity levels. *Health Education Research, 20*(1), 14–23.

Fan, X. (2001). Parental involvement and students' academic achievement: A growth modeling analysis. *The Journal of Experimental Education, 70*(1), 27–61.

Fan, X., & Chen, M. (2001). Parental involvement and students' academic achievement: A meta-analysis. *Educational Psychology Review, 13*(1), 1–22.

Feuerstein, A. (2000). School characteristics and parent involvement: Influences on participation in children's schools. *The Journal of Educational Research, 94*(1), 29–40.

Flowers, T. A., & Flowers, L. A. (2008). Factors affecting urban African American high school students' achievement in reading. *Urban Education, 43*(2), 154–171.

Fox, K. R. (2000). Self-esteem, self-perceptions and exercise. *International Journal of Sport Psychology, 31*(2), 228–240.

Gambescia, S. F. (2006). Health education and physical education are core academic subjects. *Health Promotion Practice, 7*(4), 369–371.

Gamson, D. A., Lu, X., & Eckert, S. A. (2013). Challenging the research base of the Common Core State Standards: A historical reanalysis of text complexity. *Educational Researcher, 42*(7), 381–391.

Geier, A. B., Foster, G. D., Womble, L. G., McLaughlin, J., Borradaile, K. E., Nachmani, J., Sherman, S., Kumanyika, S., & Shults, J. (2007). The relationship between relative weight and school attendance among elementary schoolchildren. *Obesity, 15*(8), 2157–2161.

Glickman, D., Parker, L., Sim, L. J., Cook, H. D. V., & Miller, E. A. (Eds.). (2012). *Accelerating progress in obesity prevention: Solving the weight of the nation*. Washington, DC: The National Academies Press.

Gonzalez-DeHass, A. R., Willems, P. P., & Holbein, M. F. D. (2005). Examining the relationship between parental involvement and student motivation. *Educational Psychology Review, 17*(2), 99–123.

Gordon-Larsen, P., McMurray, R. G., Popkin, B. M. (1999). Adolescent physical activity and inactivity vary by ethnicity: The National Longitudinal Study of Adolescent Health. *The Journal of Pediatrics, 135*(3), 301–306.

Gordon-Larsen, P., McMurray, R. G., Popkin, B. M. (2000). Determinants of adolescent physical activity and inactivity patterns. *Pediatrics*, *105*(6), e83.

Gamoran, A. (1992). The variable effects of high school tracking. *American Sociological Review, 57*(6), 812–828.

Graber, K. C. (2001). Research on teaching in physical education. In V. Richardson (Ed.), *Handbook of research on teaching* (4th Ed., pp. 491–519). Washington, DC: American Educational Research Association.

Greenleaf, C., & Weiller, K. (2005). Perceptions of youth obesity among physical educators. *Social Psychology of Education, 8*(4), 407–423.

Grissom, J. B. (2005). Physical fitness and academic achievement. *Journal of Exercise Physiology*, *8*(1), 11–25.

Haghighat, E. (2005). School social capital and pupils' academic performance. *International Studies in Sociology of Education, 15*(3), 213–236.

Ham, B. D. (2003). The effects of divorce on the academic achievement of high school seniors. *Journal of Divorce and Remarriage, 38*(3-4), 167–185.

Hannon, J. C., & Ratliffe, T. (2005). Physical activity levels in coeducational and single-gender high school physical education settings. *Journal of Teaching in Physical Education*, *24*(2), 149–164.

Harter, S., (1983). Developmental perspectives on the self-system. In E. M. Heatherington (Ed.), *Handbook of child psychology, Vol. 4: Socialization, personality and social development* (4th Ed., pp. 275–386). New York, NY: Wiley.

Haskell, W. L., Lee, I-M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., Macera, C. A., Heath, G. W., Thompson, P. D., & Bauman, A. (2007a). Physical activity and public health: Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation, 116*(9), 1081–1093.

Haskell, W. L., Lee, I-M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., Macera, C. A., Heath, G. W., Thompson, P. D., & Bauman, A. (2007b). Physical activity and public health: Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Medicine & Science in Sports & Exercise, 39*(8), 1423–1434.

Hassmén, P., Koivula, N., & Uutela, A. (2000). Physical exercise and psychological well-being: A population study in Finland. *Preventive Medicine*, *30*(1), 17–25.

Hearn, J. C. (1991). Academic and nonacademic influences on the college destinations of 1980 high school graduates. *Sociology of Education, 64*(3), 158–171.

Heelan, K. A., Unruh, S. A., Combs, J. H., Donnelly, J. E., Sutton, S., & Abbey, B. M. (2008). Walking to school: Taking research to practice. *Journal of Physical Education, Recreation & Dance*, *79*(6), 36–41.

Hein, V., & Hagger, M. S. (2007). Global self-esteem, goal achievement orientations, and self-determined behavioural regulations in a physical education setting. *Journal of Sports Sciences, 25*(2), 149–159.

Henninger, M. L., & Carlson, K. B. (2011). The marginalization of physical education: Problems and solutions. Strategies to increase the value of physical educators in K-12 Schools. *Journal of Physical Education, Recreation & Dance, 82*(6), 17–20.

Hill, N. E., Castellino, D. R., Lansford, J. E., Nowlin, P., Dodge, K. A., Bates, J. E., & Pettit, G. S. (2004). Parent academic involvement as related to school behavior, achievement, and aspirations: Demographic variations across adolescence. *Child Development, 75*(5), 1491–1509.

Hill, N. E., Ramirez, C., & Dumka, L. E. (2003). Early adolescents' career aspirations: A qualitative study of perceived barriers and family support among low income, ethnically diverse adolescents. *Journal of Family Issues, 24*(7), 934–959.

Hill, N. E., & Taylor, L. C. (2004). Parental school involvement and children's academic achievement: Pragmatics and issues. *Current Directions in Psychological Science, 13*(4), 161–164.

Hill, N. E., & Tyson, D. F. (2009). Parental involvement in middle school: A meta-analytic assessment of the strategies that promote achievement. *Developmental Psychology, 45*(3), 740–763.

Hillman, C. H., Buck, S. M., Themanson, J. R., Pontifex, M. B., & Castelli, D. M. (2009). Aerobic fitness and cognitive development: Event-related brain potential and task performance indices of executive control in preadolescent children. *Developmental Psychology, 45*(1), 114–129.

Hillman, C. H., Castelli, D. M., & Buck, S. M. (2005). Aerobic fitness and neurocognitive function in healthy preadolescent children. *Medicine & Science in Sports & Exercise, 37*(11), 1967–1974.

Hillman, C. H., Erickson, K. I., & Kramer, A. F. (2008). Be smart, exercise your heart: Exercise effects on brain and cognition. *Nature Reviews Neuroscience, 9*(1), 58–65.

Hillman, C. H., Pontifex, M. B., Castelli, D. M., Khan, N. A., Raine, L. B., Scudder, M. R., Drollette, E. S., Moore, R. D., Wu, C-T., & Kamijo, K. (2014). Effects of the FITKids randomized controlled trial on executive control and brain function. *Pediatrics, 134*(4), e1063–e1071. doi:10.1542/peds.2013-3219

Hillman, C. H., Snook, E. M., & Jerome, G. J. (2003). Acute cardiovascular exercise and executive control function. *International Journal of Psychophysiology, 48*(3), 307–314.

Holloway, S. D., Yamamoto, Y., Suzuki, S., & Mindnich, J. D. (2008). Determinants of parental involvement in early schooling: Evidence from Japan. *Early Childhood Research & Practice, 10*(1). Retrieved July 11, 2013, from http://ecrp.uiuc.edu/v10n1/holloway.html

Holt, N. L., Tink, L. N., Mandigo, J. L., & Fox, K. R. (2008). Do youth learn life skills through their involvement in high school sport? A case study. *Canadian Journal of Education, 31*(2), 281–304.

Huang, C. (2011). Self-concept and academic achievement: A meta-analysis of longitudinal relations. *Journal of School Psychology, 49*(5), 505–528.

Hunt, H. D. (2005). The effect of extracurricular activities in the educational process: Influence on academic outcomes? *Sociological Spectrum, 25*(4), 417–445.

Iannotti, R. J., & Wang, J. (2013a). Patterns of physical activity, sedentary behavior, and diet in U.S. adolescents. *Journal of Adolescent Health, 53*(2), 280–286.

Iannotti, R. J., & Wang, J. (2013b). Trends in physical activity, sedentary behavior, diet, and BMI among US adolescents, 2001–2009. *Pediatrics, 132*(4), 606–614.

Ingels, S. J., Dowd, K. L., Baldridge, J. D., Stipe, J. L., Bartot, V. H., & Frankel, M. R. (1994). *Second follow-up: Student component data file user's manual* (NCES 94–374). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Institute of Medicine. (2009). *Local government actions to prevent childhood obesity*. Washington, DC: The National Academies Press.

Institute of Medicine. (2010). *Bridging the evidence gap in obesity prevention: A framework to inform decision making.* Washington, DC: The National Academies Press.

Institute of Medicine. (2012a). *Accelerating progress in obesity prevention: Solving the weight of the nation*. Washington, DC: The National Academies Press.

Institute of Medicine. (2012b). *Measuring progress in obesity prevention: Workshop report*. Washington, DC: The National Academies Press.

Institute of Medicine. (2013a). *Educating the student body: Taking physical activity and physical education to school*. Washington, DC: The National Academies Press.

Institute of Medicine. (2013b). *Evaluating obesity prevention efforts: A plan for measuring progress.* Washington, DC: The National Academies Press.

James, A. R. (2011). The marginalization of physical education: Problems and solutions–Part 1. Introduction. *Journal of Physical Education, Recreation & Dance, 82*(6), 15–16.

Jennings, J., & Rentner, D. S. (2006). Ten big effects of the No Child Left Behind Act on public schools. *Phi Delta Kappan, 88*(2), 110–113.

Jennings, J. L., & Bearak, J. M. (2014). "Teaching to the test" in the NCLB era: How test predictability affects our understanding of student performance. *Educational Researcher, 43*(8), 381–389.

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

Jensen, E. (2005). *Teaching with the brain in mind* (2nd Ed.). Alexandria, VA: Association of Supervision and Curriculum Development.

Jeynes, W. H. (2003). A meta-analysis: The effects of parental involvement on minority children's academic achievement. *Education and Urban Society, 35*(2), 202–218.

Kalton, G. (1983). Models in the practice of survey sampling. *International Statistical Review, 51*(2), 175–188.

Kamijo, K., Khan, N. A., Pontifex, M. B., Scudder, M. R., Drollette, E. S., Raine, L. B., Evans, E. M., Castelli, D. M., & Hillman, C. H. (2012). The relation of adiposity to cognitive control and scholastic achievement in preadolescent children. *Obesity, 20*(12), 2406–2411.

Kamijo, K., Pontifex, M. B., Khan, N. A., Raine, L. B., Scudder, M. R., Drollette, E. S., Evans, E. M., Castelli, D. M., & Hillman, C. H. (2012). The association of childhood obesity to neuroelectric indices of inhibition. *Psychophysiology, 49*(10), 1361–1371.

Katz, D. L. (2012). Let's Move! Progress, promise, and the miles left to go. *Childhood Obesity, 8*(1), 2–3.

Kim, H. Y., Frongillo, E. A., Han, S. S., Oh, S. Y., Kim, W. K., Jang, Y. A., Won, H. S., Lee, H. S., & Kim, S. H. (2003). Academic performance of Korean children is associated with dietary behaviors and physical status. *Asia Pacific Journal of Clinical Nutrition, 12*(2), 186–192.

Kimm, S. Y. S., Glynn, N. W., Kriska, A. M., Barton, B. A., Kronsberg, S. S., Daniels, S. R., Crawford, P. B., Sabry, Z. I., & Liu, K. (2002). Decline in physical activity in black girls and white girls during adolescence. *The New England Journal of Medicine*, *347*(10), 709–715.

Kirby, J., Levin, K. A., & Inchley, J. (2012). Associations between the school environment and adolescent girls' physical activity. *Health Education Research, 27*(1), 101–114.

Kling, K. C., Hyde, J. S., Showers, C. J., & Buswell, B. N. (1999). Gender differences in self-esteem: A meta-analysis. *Psychological Bulletin, 125*(4), 470–500.

Knapp, T. R., & Schafer, W. D. (2009). From Gain Score t to ANCOVA F (and vice versa). *Practical Assessment, Research & Evaluation*, *14*(6), 1–7.

Kober, N, & Rentner, D. S. (2011). *States' progress and challenges in implementing Common Core State Standards.* Washington, DC: Center on Education Policy.

Kohl, H. W., III, & Cook, H. D. V. (Eds.). (2013). *Educating the student body: Taking physical activity and physical education to school*. Washington, DC: The National Academies Press.

Konstantopoulos, S. (2006). Trends of school effects on student achievement: Evidence from NLS:72, HSB:82, and NELS:92. *Teachers College Record, 108*(12), 2550–2581.

Kurtz-Costes, B. E., & Schneider, W. (1994). Self-concept, attributional beliefs, and school achievement: A longitudinal analysis. *Contemporary Educational Psychology, 19*(2), 199–216.

Kushi, L. H., Byers, T., Doyle, C., Bandera, E. V., McCullough, M., Gansler, T., Andrews, K. S., & Thun, M. J. (2006). American cancer society guidelines on nutrition and physical activity for cancer prevention: Reducing the risk of cancer with healthy food choices and physical activity. *CA: A Cancer Journal for Clinicians*, *56*(5), 254–281.

Kwak, L., Kremers, S. P. J., Bergman, P., Ruiz, J. R., Rizzo, N. S., & Sjöström, M. (2009). Associations between physical activity, fitness, and academic achievement. *The Journal of Pediatrics, 155*(6), 914–918.e1.

Lan, X., Legare, C. H., Ponitz, C. C., Li, S., & Morrison, F. J. (2011). Investigating the links between the subcomponents of executive function and academic achievement: A cross-cultural analysis of Chinese and American preschoolers. *Journal of Experimental Child Psychology, 108*(3), 677–692.

Landry, B. W., & Driscoll, S. W. (2012). Physical activity in children and adolescents. *PM&R, 4*(11), 826–832.

Le Masurier, G., & Corbin, C. B. (2006). Top 10 reasons for quality physical education. *The Journal of Physical Education, Recreation & Dance, 77*(6), 44–53.

Lee, J., & Bowen, N. K. (2006). Parent involvement, cultural capital, and the achievement gap among elementary school children. *American Educational Research Journal, 43*(2), 193–218.

Lee, V. E., & Bryk, A. S. (1989). A multilevel model of the social distribution of high school achievement. *Sociology of Education, 62*(3), 172–192.

Lee, S. M., Burgeson, C. R., Fulton, J. E., & Spain, C. G. (2007). Physical education and physical activity: Results from the School Health Policies and Programs Study 2006. *Journal of School Health, 77*(8), 435–463.

Lee, S. M., Nihiser, A. J., Fulton, J. E., Borgogna, B., & Zavacky, F. (2013). Physical education and physical activity. In Centers for Disease Control and Prevention (Ed.), *Results from the School Health Policies and Practices Study 2012* (pp. 33–47). Atlanta, GA: U.S. Department of Health and Human Services.

Lee, V. E., & Burkam, D. T. (2003). Dropping out of high school: The role of school organization and structure. *American Educational Research Journal, 40*(2), 353–393.

Lee, V. E., Burkam, D. T., Ready, D. D., Honigman, J., & Meisels, S. J. (2006). Full-day versus half-day kindergarten: In which program do children learn more? *American Journal of Education, 112*(2), 163–208.

Lee, V. E., & Smith, J. B. (1997). High school size: Which works best and for whom? *Educational Evaluation and Policy Analysis, 19*(3), 205–227.

Lee, V. E., Smith, J. B., & Croninger, R. G. (1997). How high school organization influences the equitable distribution of learning in mathematics and science. *Sociology of Education, 70*(2), 128–150.

Leek, D., Carlson, J. A., Cain, K. L., Henrichon, S., Rosenberg, D., Patrick, K., & Sallis, J. F. (2011). Physical activity during youth sports practices. *Archives of Pediatrics and Adolescent Medicine, 165*(4), 294–299.

Lehto, J. E., Juujarvi, P., Kooistra, L., & Pulkkinen, L. (2003). Dimensions of executive functioning: Evidence from children. *British Journal of Developmental Psychology, 21*(1), 59–80.

Let's Move! (2010). *Feb. 9, 2010. Washington, DC: The White House, U.S. Department of Health and Human Services, U.S. Department of Agriculture, U.S. Department of Education, U.S. Department of the Interior*. Retrieved January 2, 2013, from http://www.letsmove.gov/

Let's Move! Active Schools. (2013). *Feb. 28, 2013*. *SHAPE America, Alliance for a Healthier Generation*. Retrieved January 2, 2013, from http://www.letsmoveschools.org/

Liu, K-S, Cheng, Y-Y, Chen, Y-L, & Wu, Y-Y. (2009). Longitudinal effects of educational expectations and achievement attributions on adolescents' academic achievements. *Adolescence, 44*(176), 911–924.

Lowry, R., Wechsler, H., Galuska, D. A., Fulton, J. E., & Kann, L. (2009). Television viewing and its associations with overweight, sedentary lifestyle, and insufficient consumption of fruits and vegetables among US high school students: Differences by race, ethnicity, and gender. *Journal of School Health, 72*(10), 413–421.

Lyon, M. A. (1993). Academic self-concept and its relationship to achievement in a sample of junior high school students. *Educational and Psychological Measurement, 53*(1), 201–210.

Ma, X., Ma, L., & Bradley, K. D. (2008). Using multilevel modeling to investigate school effects. In A. A. O'Connell & D. B. McCoach (Eds.), *Multilevel modeling of educational data* (pp. 59–110). Charlotte, NC: Information Age.

MacBrayne, P. S. (1987). Educational and occupational aspirations of rural youth: A review of the literature. *Research in Rural Education, 4*(3), 135–141.

Maguire, E. A., Frith, C. D., & Morris, R. G. M. (1999). The functional neuroanatomy of comprehension and memory: The importance of prior knowledge. *Brain, 122*(10), 1839–1850.

Mahar, M. T., Murphy, S. K., Rowe, D. A., Golden, J., Shields, T. A., & Raedeke, T. D. (2006). Effects of a classroom-based program on physical activity and on-task behavior. *Medicine & Science in Sports & Exercise, 38*(12), 2086–2094.

Mandigo, J. L., Francis, N., Lodewyk, K., & Lopez, R. (2009). Physical literacy for educators. *Physical & Health Education Journal, 75*(3), 27–30.

Marsh, H. W. (1990). A multidimensional, hierarchical model of self-concept: Theoretical and empirical justification. *Educational Psychology Review, 2*(2), 77–172.

Marsh, H. W., & Kleitman, S. (2002). Extracurricular school activities: The good, the bad, and the nonlinear. *Harvard Educational Review, 72*(4), 464–514.

Martin, S., Meyer, J. A., Nelson, L., Baldwin, V., Ting, L., & Sterling, D. (2007). Locus of control, self-control, and family income as predictors of young children's mathematics and science scores. *Perceptual and Motor Skills, 104*(2), 599–610.

McKenzie, T. L., Feldman, H., Woods, S. E., Romero, K. A., Dahlstrom, V, Stone, E. J., Strikmiller, P. KI, Williston, J. M., & Harsha, D. W. (1995). Children's activity levels and lesson context during third-grade physical education. *Research Quarterly for Exercise and Sport, 66*(3), 184–193.

McKenzie, T. L., Marshall, S. J., Sallis, J. F., & Conway, T. L. (2000). Student activity levels, lesson context, and teacher behavior during middle school physical education. *Research Quarterly for Exercise and Sport, 71*(3), 249–259.

McKenzie, T. L., Nader, P. R., Strikmiller, P. K., Yang, M., Stone, E. J., Perry, C. L., Taylor, W. D., Epping, J. N., Feldman, H. A., Luepker, R. V., & Kelder, S. H. (1996). School physical education: Effect of the Child and Adolescent Trial for Cardiovascular Health. *Preventive Medicine, 25*(4), 423–431.

McLanahan, S. (1985). Family structure and the reproduction of poverty. *American Journal of Sociology, 90*(4), 873–901.

McNeal, R. B., Jr. (1999). Parental involvement as social capital: Differential effectiveness on science achievement, truancy, and dropping out. *Social Forces, 78*(1), 117–144.

McWayne, C., Hampton, V., Fantuzzo, J., Cohen, H. L., & Sekino, Y. (2004). A multivariate examination of parent involvement and the social and academic competencies of urban kindergarten children. *Psychology in the Schools, 41*(3), 363–377.

Mehta, J. (2013). How paradigms create politics: The transformation of American educational policy, 1980–2001. *American Educational Research Journal, 50*(2), 285–324.

Meier, D., & Wood, G. (Eds.) (2004). *Many children left behind: How the No Child Left Behind Act is damaging our children and our schools*. Boston, MA: Beacon Press.

Melnyk, B. M., Jacobson, D., Kelly, S., Belyea, M., Shaibi, G., Small, L., O'Haver, J., Marsiglia, F. F. (2013). Promoting healthy lifestyles in high school adolescents: A randomized controlled trial. *American Journal of Preventive Medicine, 45*(4), 407–415.

Mills, J. I. (2008). A legislative overview of No Child Left Behind. In T. Berry & R. M. Eddy (Eds.), *Consequences of No Child Left Behind for educational evaluation*. *New Directions for Evaluation, 117*, 9–20.

Mohammad, A. (2010). Relationship between self-esteem and academic achievement amongst pre-university students. *Journal of Applied Sciences, 10*(20), 2474–2477.

Monette, S., Bigras, M., & Guay, M-C. (2011). The role of the executive functions in school achievement at the end of grade 1. *Journal of Experimental Child Psychology, 109*(2), 158–173.

Mosqueda, E. (2010). Compounding inequalities: English proficiency and tracking and their relation to mathematics performance among Latina/o secondary school youth. *Journal of Urban Mathematics Education, 3*(1), 57–81.

Muijs, R. D. (1997). Predictors of academic achievement and academic self-concept: A longitudinal perspective. *British Journal of Educational Psychology, 67*(3), 263–277.

Murnane, R. J., & Willett, J. B. (2011). *Methods matter: Improving causal inference in educational and social science research*. New York, NY: Oxford University Press.

Mussoline, L. J., & Shouse, R. C. (2001). School restructuring as a policy agenda: Why one size may not fit all. *Sociology of Education*, *74*(1), 44–58.

Nader, P. R. (2003). Frequency and intensity of activity of third-grade children in physical education. *Archives of Pediatric and Adolescent Medicine, 157*(2), 185–190.

National Association for Sport and Physical Education. (2001a). *2001 Shape of the Nation Report: Status of physical education in the USA.* Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2001b). *Physical education is critical to a complete education* [Position Statement]. Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2003). *What constitutes a quality physical education program* [Position Statement]. Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2004). *Moving into the future: National standards for physical education* (2nd Ed.). Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2006a). *Opposing substitution and waiver/exemptions for required physical education* [Position Statement]. Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2006b). *Recess for elementary school students* [Position Statement]. Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2007). *What constitutes a highly qualified physical education teacher* [Position Statement]. Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2008). *Comprehensive school physical activity programs* [Position Statement]. Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2009a). *Appropriate instructional practice guidelines for elementary school physical education* [Position Statement] (3rd Ed.). Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2009b). *Appropriate instructional practice guidelines for middle school physical education* [Position Statement] (3rd Ed.). Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2009c). *Appropriate instructional practice guidelines for high school physical education* [Position Statement] (3rd Ed.). Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2009d). *Appropriate instructional practice guidelines for higher education physical activity programs* [Position Statement] (2nd Ed.). Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2009e). *Appropriate practices in movement programs for children ages 3 – 5* [Position Statement] (3rd Ed.). Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2009f). *Opportunity to learn guidelines for elementary school physical education* [Position Statement] (3rd Ed.). Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2009g). *Opportunity to learn guidelines for middle school physical education* [Position Statement] (3rd Ed.). Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2009h). *Opportunity to learn guidelines for high school physical education* [Position Statement] (3rd Ed.). Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2011). *Physical education is critical to educating the whole child* [Position Statement]. Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education. (2013). *National standards & grade-level outcomes for K–12 physical education.* Retrieved August 30, 2013, from http://www.aahperd.org/naspe/standards/nationalStandards/PEstandards.cfm

National Association for Sport and Physical Education & American Heart Association. (2006). *2006 Shape of the Nation Report: Status of physical education in the USA.* Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education & American Heart Association. (2010). *2010 Shape of the Nation Report: Status of physical education in the USA.* Reston, VA: National Association for Sport and Physical Education.

National Association for Sport and Physical Education & American Heart Association. (2012). *2012 Shape of the Nation Report: Status of physical education in the USA.* Reston, VA: Society of Health and Physical Educators.

National Center for Education Statistics. (n.d.). *1992 National Education Longitudinal Study of 1988 EDAT Extract Codebook*. Washington, DC: U.S. Department of Education, National Center for Education Statistics.

National Education Association. (2010). *Healthy kids are better students.* Retrieved October 29, 2013, from http://educationvotes.nea.org/wp-content/uploads/2010/05/StudentHealth-PhysEdOnepager.pdf

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards.* Washington, DC: National Governors Association Center for Best Practices & Council of Chief State School Officers. Retrieved September 9, 2013, from http://www.corestandards.org/the-standards

National Institutes of Health. (1995). Physical activity and cardiovascular health. NIH Consensus Development Conference Statement 1995 December 18-20, 13(3), 1–33. Retrieved Sept. 17, 2014, from http://consensus.nih.gov/1995/1995ActivityCardivascularHealth101html.htm

National Institutes of Health. (1996). Physical activity and cardiovascular health. NIH Consensus Development Panel on Physical Activity and Cardiovascular Health. *The Journal of the American Medical Association, 276*(3), 241–246.

National Research Council & Institute of Medicine. (2013). *U.S. health in international perspective: Shorter lives, poorer health.* Washington, DC: The National Academies Press.

Naylor, P-J., & McKay, H. A. (2009). Prevention in the first place: Schools a setting for action on physical inactivity. *British Journal of Sports Medicine, 43*(1), 10–13.

Nelson, M. C., & Gordon-Larsen, P. (2006). Physical activity and sedentary behavior patterns are associated with selected adolescent health risk behaviors. *Pediatrics, 117*(4), 1281–1290.

Nelson, M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Judge, J. O., King, A. C., Macera, C. A., & Castaneda-Sceppa, C. (2007a). Physical activity and public health in older adults: Recommendation from the American College of Sports Medicine and the American Heart Association. *Circulation, 116*(9), 1094–1105.

Nelson, M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Judge, J. O., King, A. C., Macera, C. A., & Castaneda-Sceppa, C. (2007b). Physical activity and public health in older adults: Recommendation from the American College of Sports Medicine and the American Heart Association. *Medicine & Science in Sports & Exercise, 39*(8), 1435–1445.

No Child Left Behind Act of 2001. (2002). *Public Law 107–110—Jan. 8, 2002, 115 Stat. 1425–2094*. Retrieved January 3, 2013, from http://www2.ed.gov/policy/elsec/leg/esea02/107-110.pdf

Obama, M. (2012a). Let’s keep moving! *The Phi Delta Kappan, 93*(7), 8–9.

Obama, M. (2012b). Let’s Move! Raising a healthier generation of kids. *Childhood Obesity, 8*(1), 1–1.

O’Conner, S. A., & Miranda, K. (2002). The linkages among family structure, self-concept, effort, and performance on mathematics achievement of American high school students by race. *American Secondary Education, 31*(1), 72–95.

Ogden, C. L., Carroll, M. D., Curtin, L. R., Lamb, M. M., & Flegal, K. M. (2010). Prevalence of high body mass index in US children and adolescents, 2007–2008. *The Journal of the American Medical Association, 303*(3), 242–249.

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2012). Prevalence of obesity and trends in body mass index among US children and adolescents, 1999–2010. *The Journal of the American Medical Association, 307*(5), 483–490.

Pate, R. R., Heath, G. W., Dowda, M., & Trost, S. G. (1996). Associations between physical activity and other health behaviors in a representative sample of US adolescents. *American Journal of Public Health, 86*(11), 1577–1581.

Pate, R. R., Davis, M. G., Robinson, T. N., Stone, E. J., McKenzie, T. L., & Young, J. C. (2006). Promoting physical activity in children and youth: A leadership role for schools. A scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism (Physical Activity Committee) in collaboration with the Councils on Cardiovascular Disease in the Young and Cardiovascular Nursing [AHA Scientific Statement]. *Circulation, 114*(11), 1214–1224.

Pate, R. R., Ward, D. S., O'Neill, J. R., & Dowda, M. (2007). Enrollment in physical education is associated with overall physical activity in adolescent girls. *Research Quarterly for Exercise and Sport, 78*(4), 265–270.

Paus, T. (2005). Mapping brain maturation and cognitive development during adolescence. *Trends in Cognitive Sciences, 9*(2), 60–68.

Pearson, N., & Biddle, S. J. H. (2011). Sedentary behavior and dietary intake in children, adolescents, and adults: A systematic review. *American Journal of Preventive Medicine, 41*(2), 178–188.

Peng, S. S., & Wright, D. (1994). Explanation of academic achievement of Asian American students. *The Journal of Educational Research, 87*(6), 346–352.

Penney, D. (2010). *Recent research into the value of quality physical education and school sport.* Retrieved October 10, 2013, from http://www.activate.vic.edu.au/__files/f/1253/Value%20of%20a%20quality%20PE%20program.pdf

Perna, L. W., & Titus, M. A. (2005). The relationship between parental involvement as social capital and college enrollment: An examination of racial/ethnic group differences. *The Journal of Higher Education, 76*(5), 485–518.

President's Council on Fitness, Sports and Nutrition. (2000, March). Definitions: Health, fitness, and physical activity. *Research Digest, 3*(9), 1–10.

President's Council on Fitness, Sports and Nutrition. (2003, June). The compendium of physical activities. *Research Digest, 4*(2), 1–8.

President's Council on Fitness, Sports and Nutrition. (2012). *Physical activity guidelines for Americans midcourse report: Strategies to increase physical activity among youth.* Washington, DC: U.S. Department of Health and Human Services.

Pong, S-L. (1997). Family structure, school context, and eighth-grade math and reading achievement. *Journal of Marriage and Family, 59*(3), 734–746.

Pong, S-L. (1998). The school compositional effect of single parenthood on 10th-grade achievement. *Sociology of Education, 71*(1), 23–42.

Pong, S-L, & Ju, D. (2000). The effects of change in family structure and income on dropping out of middle and high school. *Journal of Family Issues, 21*(2), 147–169.

Porter, A., McMaken, J., Hwang, J., & Yang, R. (2011). Common Core Standards: The new U.S. intended curriculum. *Educational Researcher, 40*(3), 103–116.

Powers, H. S., Conway, T. L., McKenzie, T. L., Sallis, J. F., & Marshall, S. J. (2002). Participation in extracurricular physical activity programs at middle schools. *Research Quarterly for Exercise and Sport, 73*(2), 187–192.

Pühse, U., & Gerber, M. (Eds.). (2005). *International comparison of physical education: Concepts, problems, prospects.* Oxford: Meyer & Meyer Sport.

Quaglia, R. (1989). Student aspirations: A critical dimension in effective schools. *Research in Rural Education, 6*(2), 7–9.

Quaglia, R. J., & Cobb, C. D. (1996). Toward a theory of student aspirations. *Journal of Research in Rural Education, 12*(3), 127–132.

Raine, L. B., Lee, H., Saliba, B. J., Chaddock-Heyman, L., Hillman, C. H., & Kramer, A. F. (2013). The influence of childhood aerobic fitness on learning and memory. *PLoS ONE, 8*(9), 1–6.

Rasberry, C. N., Lee, S. M., Robin, L., Laris, B. A., Russell, L. A., Coyle, K. K., & Nihiser, A. J. (2011). The association between school-based physical activity, including physical education, and academic performance: A systematic review of the literature. *Preventive Medicine, 52*(Suppl. 1), S10–S20.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd Ed.). Thousand Oaks, CA: SAGE Publications.

Rauner, R. R., Walters, R. W., Avery, M., & Wanser, T. J. (2013). Evidence that aerobic fitness is more salient than weight status in predicting standardized math and reading outcomes in fourth- through eighth-grade students. *The Journal of Pediatrics, 163*(2), 344–348.

Raviv, S., & Low, M. (1990). Influence of physical activity on concentration among junior high-school students. *Perceptual and Motor Skills, 70*(1), 67–74.

Reilly, E., Buskist, C., & Gross, M. K. (2012). Movement in the classroom: Boosting brain power, fighting obesity. *Kappa Delta Pi Record, 48*(2), 62–66.

Riggs, N. R., Blair, C. B., & Greenberg, M. T. (2003). Concurrent and 2-year longitudinal relations between executive function and the behavior of 1st and 2nd grade children. *Child Neuropsychology, 9*(4), 267–276.

Ripski, M. B., & Gregory, A. (2009). Unfair, unsafe, and unwelcome: Do high school students' perceptions of unfairness, hostility, and victimization in school predict engagement and achievement? *Journal of School Violence, 8*(4), 355–375.

Rock, D. A., & Pollack, J. M. (1995). *Psychometric report for the NELS:88 base year through second follow-up* (NCES 95–382). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

Rosenberg, M. (1979). *Conceiving the self.* New York, NY: Basic Books.

Rosenberg, M., Schooler, C., Schoenbach, C., & Rosenberg, F. (1995). Global self-esteem and specific self-esteem: Different concepts, different outcomes. *American Sociological Review, 60*(1), 141–156.

Rouse, C. E., & Barrow, L. (2006). U.S. elementary and secondary schools: Equalizing opportunity or replicating the status quo? *The Future of Children, 16*(2), 99–123.

Rowan, B., Chiang, F-S., & Miller, R. J. (1997). Using research on employees' performance to study the effects of teachers on students' achievement. *Sociology of Education, 70*(4), 256–284.

Rumberger, R. W., & Palardy, G. J. (2005). Test scores, dropout rates, and transfer rates as alternative indicators of high school performance. *American Educational Research Journal, 42*(1), 3–42.

Sallis, J. F. (2010). We do not have to sacrifice children's health to achieve academic goals. *The Journal of Pediatrics, 156*(5), 696–697.

Sallis, J. F., & McKenzie, T. L. (1991). Physical education's role in public health. *Research Quarterly for Exercise and Sport, 62*(2), 124–137.

Sallis, J. F., McKenzie, T. L., Alcaraz, J. E., Kolody, B., Faucette, N., & Hovell, M. F. (1997). The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. Sports, Play and Active Recreation for Kids. *American Journal of Public Health, 87*(8), 1328–1334.

Sallis, J. F., McKenzie, T. L., Beets, M. W., Beighle, A., Erwin, H., & Lee, S. (2012). Physical education role in public health: Steps forward and backward over 20 years and HOPE for the future. *Research Quarterly for Exercise and Sport, 83*(2), 125–135.

Sallis, J. F., McKenzie, T. L., Kolody, B., Lewis, M., Marshall, S., & Paul, R. (1999). Effects of health-related physical education on academic achievement: Project SPARK. *Research Quarterly for Exercise and Sport, 70*(2), 127–134.

Sarkin, J. A., McKenzie, T. L., & Sallis, J. F. (1997). Gender differences in physical activity during fifth-grade physical education and recess periods. *Journal of Teaching in Physical Education, 17*(1), 99–106.

Scheirer, M. A., & Kraut, R. E. (1979). Increasing educational achievement via self concept change. *Review of Educational Research, 49*(1), 131–149.

Schwimmer, J. B., Burwinkle, T. M., Varni, J. W. (2003). Health-related quality of life of severely obese children and adolescents. *The Journal of the American Medical Association, 289*(14), 1813–1819.

Seginer, R., & Vermulst, A. (2002). Family environment, educational aspirations, and academic achievement in two cultural settings. *Journal of Cross-Cultural Psychology, 33*(6), 540–558.

Sellström, E., & Bremberg, S. (2006). Is there a “school effect” on pupil outcomes? A review of multilevel studies. *Journal of Epidemiology & Community Health, 60*(2), 149–155.

Seyfried, S. F., & Chung, I. (2002). Parent involvement as parental monitoring of student motivation and parent expectations predicting later achievement among African American and European American middle school age students. *Journal of Ethnic & Cultural Diversity in Social Work, 11*(1-2), 109–131.

Shavelson, R. J., & Bolus, R. (1982). Self-concept: The interplay of theory and methods. *Journal of Educational Psychology, 74*(1), 3–17.

Shavelson, R. J., Hubner, J. J., & Stanton, G. C. (1976). Self-concept: Validation of construct interpretations. *Review of Educational Research, 46*(3), 407–441.

Shephard, R. J. (1996). Habitual physical activity and academic performance. *Nutrition Reviews, 54*(4), S32–S36.

Shephard, R. J. (1997). Curricular physical activity and academic performance. *Pediatric Exercise Science, 9*(2), 113–126.

Sibley, B. A., & Etnier, J. L. (2003). The relationship between physical activity and cognition in children: A meta-analysis. *Pediatric Exercise Science, 15*(3), 243–256.

Siedentop, D.L. (2009). National plan for physical activity: Education sector. *Journal of Physical Activity and Health, 6*(Suppl. 2), S168–S180.

Simons-Morton, B. G., Taylor, W. C., Snider, S. A., Huang, I. W., & Fulton, J. E. (1994). Observed levels of elementary and middle school children’s physical activity during physical education classes. *Preventive Medicine, 23*(4), 437–441.

Singh, K., Bickley, P. G., Trivette, P., Keith, T. Z., Keith, P. B., & Anderson, E. (1995). The effects of four components of parental involvement on eighth-grade student achievement: Structural analysis of NELS-88 data. *School Psychology Review, 24*(2), 299–317.

Smith, N. J., & Lounsbery, M. (2009). Promoting physical education: The link to academic achievement. *Journal of Physical Education, Recreation & Dance, 80*(1), 39–43.

Society of Health and Physical Educators. (2013a). *Comprehensive school physical activity programs: Helping students achieve 60 minutes of physical activity each day* [Position Statement]. Reston, VA: Society of Health and Physical Educators.

Society of Health and Physical Educators. (2013b). *Developing "physically literate" individuals.* Retrieved August 31, 2013, from http://www.aahperd.org/about/announcements/new-national-standards.cfm

Society of Health and Physical Educators. (2013c). *Grade-level outcomes for K–12 physical education.* Reston, VA: Society of Health and Physical Educators.

Society of Health and Physical Educators. (2013d). Let's Move in school becomes First Lady's Let's Move! Active Schools. *Journal of Physical Education, Recreation & Dance, 84*(4), 3–3.

Society of Health and Physical Educators. (2013e, Summer). New national standards for physical education. *Momentum, 1,* 6–6.

Society of Health and Physical Educators. (2014). *National standards & grade-level outcomes for K–12 physical education.* Champaign, IL: Human Kinetics.

Society of Health and Physical Educators. (2015). *The essential components of physical education* [Guidance Document]. Reston, VA: Society of Health and Physical Educators.

Sports, Play, and Active Recreation for Kids. (2013a). *SPARK elementary physical education (grades K–5) alignment to the Common Core: Making the connections – Meeting the standards in English/language arts & literacy in technical subjects*. Retrieved August 27, 2013, from http://www.sparkpe.org/wp-content/uploads/4-13-Common-Core-K-5-Alignments-to-Literacy.pdf

Sports, Play, and Active Recreation for Kids. (2013b). *SPARK middle and high school physical education (grades 6–12) alignment to the Common Core: Making the connections – Meeting the standards in English/language arts & literacy in technical subjects*. Retrieved August 27, 2013, from http://www.sparkpe.org/wp-content/uploads/4-13-Common-Core-6-12-Alignments-to-Literacy.pdf

Sports, Play, and Active Recreation for Kids & Association for Supervision and Curriculum Development. (2013, April). *Connecting physical education to Common Core State Standards*. Retrieved August 27, 2013, from http://vimeo.com/64842135

St Clair-Thompson, H. L., & Gathercole, S. E. (2006). Executive functions and achievements in school: Shifting, updating, inhibition, and working memory. *The Quarterly Journal of Experimental Psychology, 59*(4), 745–759.

Stapleton, L. M., & Kang, Y. (2012, April). *Design effects for multilevel analyses of typical data from the National Center for Education Statistics*. Paper presented at the annual meeting of the American Educational Research Association, Special Interest Group: Hierarchical Linear Modeling, Vancouver, Canada.

Steinberg, L. (2005). Cognitive and affective development in adolescence. *Trends in Cognitive Sciences, 9*(2), 69–74.

Stephens, L. J., & Schaben, L. A. (2002). The effect of interscholastic sports participation on academic achievement of middle level school students. *NASSP Bulletin, 86*(630), 34–41.

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. *Journal of Sport Behavior, 31*(4), 368–388.

Stewart, E. B. (2008). School structural characteristics, student effort, peer associations, and parental involvement: The influence of school- and individual-level factors on academic achievement. *Education and Urban Society, 40*(2), 179–204.

Story, M., Nanney, M. S., & Schwartz, M. B. (2009). Schools and obesity prevention: Creating school environments and policies to promote healthy eating and physical activity. *The Milbank Quarterly, 87*(1), 71–100.

Strong, W. B., Malina, R. M., Blimkie, C. J. R., Daniels, S. R., Dishman, R. K., Gutin, B., Hergenroeder, A. C., Must, A., Nixon, P. A., Pivarnik, J. M., Rowland, T., Trost, S., Trudeau, F. (2005). Evidence based physical activity for school-age youth. *The Journal of Pediatrics, 146*(6), 732–737.

Sui-Chu, E. H., & Willms, J. D. (1996). Effects of parental involvement on eighth-grade achievement. *Sociology of Education, 69*(2), 126–141.

Summerford, C. (2001). What is the impact of exercise on brain function for academic learning. *Teaching Elementary Physical Education, 12*(3), 6–8.

Sun, Y., & Li, Y. (2009). Postdivorce family stability and changes in adolescents' academic performance: A Growth-Curve Model. *Journal of Family Issues, 30*(11), 1527–1555.

Tam, N. D. (2013). Improvement of processing speed in executive function immediately following an increase in cardiovascular activity. *Cardiovascular Psychiatry and Neurology, 2013*, 1–6. doi:10.1155/2013/212767

Taras, H. (2005). Physical activity and student performance at school. *Journal of School Health*, *75*(6), 214–218.

Taras, H., & Potts-Datema, W. (2005). Obesity and student performance at school. *Journal of School Health, 75*(8), 291–295.

Taylor, K., & Lamoreaux, A. (2008). Teaching with the brain in mind. In S. B. Merriam (Ed.), *Third update on adult learning theory*. *New Directions for Adult and Continuing Education, 119,* 49–59.

Texas Education Agency. (2009, March 9). *Physically fit students more likely to do well in school, less likely to be disciplinary problems.* Austin, TX: Texas Education Agency News.

The White House. (2010, February 9). *First Lady Michelle Obama launches Let's Move: America's move to raise a healthier generation of kids*. Washington, DC: The White House. Retrieved January 2, 2013, from http://www.whitehouse.gov/the-press-office/first-lady-michelle-obama-launches-lets-move-americas-move-raise-a-healthier-genera

The White House. (2013, February 28). *First Lady Michelle Obama announces unprecedented collaboration to bring physical activity back to schools*. Washington, DC: The White House. Retrieved January 2, 2013, from http://www.whitehouse.gov/the-press-office/2013/02/28/first-lady-michelle-obama-announces-unprecedented-collaboration-bring-ph

Thomas, K. T. (2004). Riding to the rescue while holding on by a thread: Physical activity in the schools. *Quest, 56*(1), 150–170.

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

Toutkoushian, R. K., & Curtis, T. (2005). Effects of socioeconomic factors on public high school outcomes and rankings. *The Journal of Educational Research, 98*(5), 259–271.

Tremarche, P. V., Robinson, E. M., & Graham, L. B. (2007). Physical education and its effect on elementary testing results. *Physical Educator, 64*(2), 58–64.

Tremblay, M. S., Inman, J. W., & Willms, J. D. (2000). The relationship between physical activity, self-esteem, and academic achievement in 12-year-old children. *Pediatric Exercise Science, 12*(3), 312–323.

Tremblay, M. S., & Lloyd, M. (2010). Physical literacy measurement – The missing piece. *Physical & Health Education Journal, 76*(1), 26–30.

Trost, S. G. (2007). *Active education: Physical education, physical activity, and academic performance.* San Diego, CA: Active Living Research.

Trost, S. G. (2009). *Active education: Physical education, physical activity, and academic performance.* San Diego, CA: Active Living Research.

Trost, S. G., & van der Mars, H. (2009). Why we should not cut P.E. *Educational Leadership, 67*(4), 60–65.

Trudeau, F., & Shephard, R. J. (2008). Physical education, school physical activity, school sports and academic performance. *International Journal of Behavioral Nutrition and Physical Activity, 5*(1), 10. doi:10.1186/1479-5868-5-10

Trust for America's Health & Robert Wood Johnson Foundation. (2012). F as in fat: How obesity threatens America's future 2013. Washington, DC: Trust for America's Health.

Trust for America's Health & Robert Wood Johnson Foundation. (2013). F as in fat: How obesity threatens America's future 2013. Washington, DC: Trust for America's Health.

U.S. Department of Health and Human Services. (1999). *Promoting physical activity: A guide for community action.* Champaign, IL: Human Kinetics.

U.S. Department of Health and Human Services. (2000). *Healthy People 2010.* Washington, DC: U.S. Government Printing Office.

U.S. Department of Health and Human Services. (2001). *The Surgeon General's Call to Action to prevent and decrease overweight and obesity.* Rockville, MD: Office of the Surgeon General.

U.S. Department of Health and Human Services. (2008). *2008 Physical activity guidelines for Americans: Be active, healthy, and happy!* Washington, DC: U.S. Government Printing Office.

U.S. Department of Health and Human Services. (2010a). *Healthy People 2020.* Washington, DC: U.S. Government Printing Office.

U.S. Department of Health and Human Services. (2010b). *The Surgeon General's Vision for a healthy and fit nation.* Rockville, MD: Office of the Surgeon General.

Valentine, J. C., DuBois, D. L., & Cooper, H. (2004). The relation between self-beliefs and academic achievement: A meta-analytic review. *Educational Psychologist, 39*(2), 111–133.

Van Cleave, J., Gortmaker, S. L., & Perrin, J. M. (2010). Dynamics of obesity and chronic health conditions among children and youth. *The Journal of the American Medical Association, 303*(7), 623–630.

Waber, D. P., Gerber, E. B., Turcios, V. Y., Wagner, E. R., & Forbes, P. W. (2006). Executive functions and performance on high-stakes testing in children from urban schools. *Developmental Neuropsychology, 29*(3), 459–477.

Walberg, H. J., & Greenberg, R. (1996). Youth realities and aspirations. Journal of *Research in Rural Education*, *12*(3), 178–180.

Wang, Z., & Su, I. (2013). Longitudinal factor structure of general self-concept and locus of control among high school students. *Journal of Psychoeducational Assessment, 31*(6), 554–565.

Webster, B. J., & Fisher, D. L. (2000). Accounting for variation in science and mathematics achievement: A multilevel analysis of Australian data Third International Mathematics and Science Study (TIMSS). *School Effectiveness and School Improvement, 11*(3), 339–360.

Werblow, J., & Duesbery, L. (2009). The impact of high school size on math achievement and dropout rate. *The High School Journal*, *92*(3), 14–23.

Whitehead, J. R., & Corbin, C. B. (1997). Self-esteem in children and youth: The role of sport and physical education. In K. R. Fox (Ed.), *The physical self: From motivation to well-being* (pp. 175–203). Champaign, IL: Human Kinetics.

Wilgenbusch, T., & Merrell, K. W. (1999). Gender differences in self-concept among children and adolescents: A meta-analysis of multidimensional studies. *School Psychology Quarterly, 14*(2), 101–120.

Wilkins, J. L. M., Graham, G., Parker, S., Westfall, S., Fraser, R. G., & Tembo, M. (2003). Time in the arts and physical education and school achievement. *Journal of Curriculum Studies, 35*(6), 721–734.

Williamson, G. L., Fitzgerald, J., & Stenner, A. J. (2013). The Common Core State Standards' quantitative text complexity trajectory: Figuring out how much complexity is enough. *Educational Researcher, 42*(2), 59–69.

Woolf, S. H., & Aron, L. (Eds.). (2013). *U.S. health in international perspective: Shorter lives, poorer health.* Washington, DC: The National Academies Press.

World Health Organization. (2008). *The global burden of disease: 2004 update*. Geneva: World Health Organization.

World Health Organization. (2009). *Global health risks: Mortality and burden of disease attributable to selected major risks*. Geneva: World Health Organization.

World Health Organization. (2010). *Global recommendations on physical activity for health.* Geneva: World Health Organization.

Xu, F., Chepyator-Thomson, J., Liu, W., & Schmidlein, R. (2010). Association between social and environmental factors and physical activity opportunities in middle schools. *European Physical Education Review, 16*(2), 183–194.

Young, D. J. (1998). Rural and urban differences in student achievement in science and mathematics: A multilevel analysis. *School Effectiveness and School Improvement, 9*(4), 386–418.

Young, D. R., Felton, G. M., Grieser, M., Elder, J. P., Johnson, C., Lee, J. S., & Kubik, M. Y. (2007). Policies and opportunities for physical activity in middle school environments. *Journal of School Health, 77*(1), 41–47.

Yu, C. C. W., Chan, S., Cheng, F., Sung, R. Y. T., & Hau, K-T. (2006). Are physical activity and academic performance compatible? Academic achievement, conduct, physical activity and self-esteem of Hong Kong Chinese primary school children. *Educational Studies, 32*(4), 331–341.

Yurgelun-Todd, D. (2007). Emotional and cognitive changes during adolescence. *Current Opinion in Neurobiology, 17*(2), 251–257.