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With increased obesity rate and decreased physical activity among children and adolescents, it is crucial to provide ample opportunities for them to increase energy expenditure through moderate-to-vigorous physical activity. To help children and adolescents develop and sustain an energy-balanced living through healthy eating and physical activity, it is equally important to nurture their self-initiated motivation and essential knowledge about balancing energy intake and expenditure. Guided by the expectancy-value theory and the conceptual change learning perspective, this descriptive study was aimed to addressing three research questions: (a) To what extent did expectancy-value constructs affect energy-balance knowledge, in-class and after-school physical activity? (b) To what extent did ninth graders correctly construct their mental representations about energy-balance knowledge? And (c) To what extent did their mental representations developed in health education affect physical activity behavior in physical education and after-school hours? A total of 195 ninth grade students studied 14 energy-balance concepts in classroom-based health education classes and participated in daily physical education. Expectancy-value motivation, energy-balance knowledge, in-class physical activity and after-school physical activity were measured using the *Expectancy-Value Questionnaire*, concept-mapping, accelerometry, and *Three-Day Physical Activity Recall Survey*. The descriptive statistical analysis, structural equation modeling, and logistic regression analysis revealed that (a) the role of expectancy-value motivation is complex. Four alternative structural equation models differentiated the

facilitating roles of expectancy beliefs and intrinsic value toward in-physical education physical activity from the detrimental role of cost perceived in physical education toward after-school physical activity. (b) The students learned the energy-balance knowledge from the same sources but constructed the knowledge in different mental representations. Most of the mental representations were found to be premature. Consistent with the constructivist theory, the finding suggests a low likelihood that the knowledge would play a guiding role in developing energy-balanced living behavior. (c) Energy-balance knowledge learned in health classes without experiencing physical activities was detached from physical activity in physical education and after-school leisure times. Separating energy-balance knowledge from physical activity in the learning process de-contextualized the learning experience. The findings call for change in teaching physical activity related health concepts by incorporating them in physical education classes. Overall the findings indicate a need for physical educators to strengthen students' expectancy beliefs for success and intrinsic value in tasks, but minimize their cost perceptions. In addition, curricular reform should target integrating concepts in health with meaningful physical activities to help students develop relational knowing structures that can be used to guide behavior change and/or enhancement.

NINTH GRADERS' EXPECTANCY-VALUE MOTIVATION,
ENERGY-BALANCE KNOWLEDGE,
AND PHYSICAL ACTIVITY

by

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To my beloved father who envisioned, planned, invested, but never witnessed my success
in higher education

APPROVAL PAGE

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CHAPTER I

INTRODUCTION

Among American teen-agers (from 12 to 19 years old), 34.2% are overweight and 18.1% are obese (Ogden, Carroll, Curtin, Lamb & Flegal, 2010). These ratios become alarmingly higher as teen-agers grow into adulthood. Recent data show that 68.3% of adults are overweight, and 33.9% are obese (Flegal, Carroll, Ogden, & Curtin, 2010). Obesity is found from childhood to adulthood; about one third of obese preschool children and half obese school-aged youth become obese adults (Serdula et al., 1993). Obesity has been identified as an epidemic and has drawn widespread attention and efforts (e.g., Centers for Disease Control and Prevention [CDC], 2009). Essential knowledge associated with healthful-living (Ennis, 2007; 2010), physical activity (CDC, 2009), and student motivation (Chen & Ennis, 2004; 2009; Salis & McKenzie, 1991) are three instrumental variables in countering this epidemic. Embodied in a physical education curriculum, students' learning of essential knowledge could inform their subsequent healthful living behaviors such as increases in physical activity; while student motivation could facilitate engagement in constructing knowledge and participating in the organized physical activities. The interactions among the three variables are expected to contribute to combating the obesity epidemic.

Obesity is a state in which an individual has body fat in amounts far exceeding biological needs, and is often the result of a small but chronic positive energy imbalance

over a prolonged period of time (Jeffery & Harnack, 2007). Positive energy imbalance refers to the scenario that energy intake exceeds energy expenditure; vice versa for negative energy imbalance (Dunford, 2010). Mathematically, every excessive 3500 to 4000 Kcal energy beyond what the body needs will result in one pound of body fat (subject to variations in body functions such as metabolism rate) (Dunford, 2010; Katz, 2010). National data that compared Americans from 1971 to 2000 indicated that energy intake increased 168 Kcal/day or 7% among men, and 335 Kcal/day or 22% among women (Wright, Kennedy, Wang, McDowell, & Johnson, 2004). This increase in energy intake has also been accompanied by the more sedentary lifestyle in today's automated society in contrast with decades ago (Hamilton, Hamilton, & Zderic, 2007). Thus, the increased energy intake and decreased energy expenditure could account for the positive energy imbalance underlying fat accumulation and obesity.

To counter the obesity epidemic, it is crucial to achieve the balance or negative imbalance in some cases between energy intake from food and beverages and energy expenditure through physical activity and body functions (Dunford, 2010). Education with regard to the energy-balance knowledge and its implications targeting people at a young age appears to be a feasible and important channel to promote changes in healthful behaviors. Scientific conceptions of energy balance nurtured in education might become engrained in mind and then give rise to these behaviors. Physical education with a constructivist approach seems to be the ideal venue to teach energy-balance knowledge. The reasons are two-folds. First, a primary focus of constructivist physical education is to engage students using essential knowledge to make decisions and solve problems

associated with performance and well-being (Ennis, 2007). Students who have constructed scientific conceptions of energy balance are more likely to make appropriate decisions regarding food and physical activity choices (Contento, Koch, Lee, & Calabrese-Barton, 2010). Second, physical education offers ample opportunities for physical activities. It provides the environment for all students to expend energy in order to achieve the state of energy balance or negative energy imbalance through participation in various organized physical activities.

Physical activity has been considered as the primary approach to increasing energy expenditure (Peterson, Palmer, & Laubach, 2004; Rixon, Rehor, & Bemben, 2006). Regular physical activity has positive effect on body fat fluctuation. In a study that followed 16 pairs of twin brothers for 32 years, Leskinen et al. (2009) demonstrated that the co-twins who maintained regular physical activity had significantly lower accumulation of body fat over time than the ones who were physically inactive (Leskinen et al., 2009). After having controlled for variations in genetic liability and childhood environment, this study has pinpointed the important role of regular physical activity in battling the obesity epidemic. It endorses the national and regional calls for physical activity interventions at all age levels (CDC, 2009).

Nevertheless, an individual's physical activity pattern does not change without effortful interventions. It is argued that radical restructuring of one's fundamental presuppositions might be necessary to welcome these changes; major instructional innovations should be in place to stimulate radical conceptual and behavioral changes (Ennis, 2007). Contento and colleagues (2010) conducted a 24-lesson-long curriculum

intervention among 562 secondary school students (Age: $M = 12$, ranging from 11 to 13). The curriculum utilized instructional and motivational strategies to facilitate students' adoption of behaviors associated with energy balance (i.e., decreasing sweetened drinks, packaged snacks, fast food, and leisure screen time, while increasing water, fruits and vegetables, and physical activity). The study found that participants significantly increased physical activity level and reduced daily energy intake after the intervention (Contento et al., 2010). This study demonstrates that gaining scientific conception of energy balance and the strategies to effectively manipulate energy balance can create efficacy needed for adolescents to change healthful behaviors, including physical activity patterns.

Additionally, constructing essential knowledge and changing habitual behaviors such as the patterns of eating, drinking, and physical inactivity require an individual to develop an adaptive motivation process. Chen et al. (in press) identified expectancy-value motivation as the strongest motivators for K-12 physical education students. Expectancy beliefs for success refer to the expectancy for success in a future task; while subjective task values refer to the perceived worth of a given task, which includes attainment, utility, interest, and cost dimensions (Eccles & Wigfield, 1995). While learning energy-balance knowledge in an educational context, students tend to perceive intuitively the attainment, utility, and interest values and potential costs. The first and foremost implication of energy balance lies in its utility value to health. The energy-balance knowledge serves as the primary scientific explanation for body weight fluctuation. Being aware of this utility value, a student who desires to lose weight might engage in healthful behaviors to

achieve the negative energy imbalance status for a prolonged period of time. In addition, the utility value of learning energy-balance knowledge is likely to urge the student to deem energy balance as important; thus the attainment value surfaces. Further, the intrinsic/interest value and perceived costs in learning the knowledge are subject to the process of instruction. For example, creating an engaging and meaningful learning environment for students to construct the knowledge could be perceived as interesting (i.e., intrinsic/interest value). In contrast, the teaching practice that requires students to memorize the energy-balance knowledge through rote learning might be perceived as boring, difficult, hence as a cost. On the basis of the perceived values and costs, students' expectancy beliefs for success might fluctuate. Expectancy beliefs strengthen as the values are more salient than costs, or mitigate when costs overshadow values.

Taken together above conceptualization, the purpose of this dissertation was to articulate the extent to which expectancy-value motivation, energy-balance knowledge, and physical activity interact with each other. In the following sections, I elucidated the theoretical frameworks of learning and motivation and then adopted my preliminary studies as core literature to identify and justify research questions for the dissertation. In-depth literature review was synthesized in the Chapter II.

Theoretical Frameworks

Researchers in education have identified a spectrum of learning theories. Shuell (1986) established three criteria for defining the concept of learning: "(a) a change in an individual's behavior or ability to do something, (b) a stipulation that this change must result from some sort of practice or experience, and (c) a stipulation that the change is an

enduring one” (p. 412). More recently, Alexander, Schaller, and Reynolds (2009) defined learning as “a multidimensional process that results in a relatively enduring change in a person or persons, and consequently how that person or persons will perceive the world and reciprocally respond to its affordances physically, psychologically, and socially” (p. 186). In comparison, both definitions stressed “enduring change”. However, Alexander et al. (2009)’s definition implies that the “enduring change” is not only physically in behaviors, but also in psychological and social conceptions. In essence, it is reasonable to deem enduring conceptual change and behavioral change as two types of learning that go hand-in-hand in physical education throughout this dissertation.

Learning as Conceptual Change

Learning is incomplete if conceptual change does not take place (Ennis, 2007; Posner, Strike, Hewson, & Gertzog, 1982). According to the *Framework Theory of Conceptual Change*, conceptual change refers to the change or transformation in an individual’s mental representations of external entities during cognitive functioning (Vosniadou, 1994). These dynamic and generative mental representations are considered mental models that lead the learner to causal explanation of physical phenomena and predictions about the state of future affairs (Vosniadou, 1994). Mental models are domain-specific knowledge structures that learners use to build their idiosyncratic conception of knowledge (Alexander, 2006). An intuitive mental model symbolizes one’s initial mental representation of knowledge/concepts, which is subject to prior informal knowledge and experiences in daily life (Vosniadou, 1994). It is often characterized by misconceptions, namely, erroneous ideas or naïve conceptions (Alexander, 2006). For

example, in a physical education class, a student who does not have the prior energy-balance knowledge might erroneously perceive obesity as the result of genetic make-up alone. Thus, this misconception would make it difficult for him/her to attempt to modify energy intake/expenditure behaviors and manage body weight.

Scientific mental models, on the other hand, represent scientifically correct conceptions that are culturally accepted or verified (Vosniadou, 1994). It is the knowledge structure that educators expect students to develop in schooling. For example, after having gained a good understanding of energy balance, the student then can explain the causes of obesity by taking into account energy intake and expenditures. A mental model that a learner often demonstrates during learning is a synthetic model. It is the mental representation that integrates and reconciles intuitive and scientific conceptions (Vosniadou, 1994). It is a transitional mental model positioned along the continuum from intuitive to scientific mental model. Continuing to use the above example, a synthetic mental model could be represented by the student's partial understanding of energy balance. He/she might firmly believe that an increase in sports or organized physical activities participation is the sole method to increase energy expenditure, although non-exercise physical activities and others also play important roles.

Mental models could evolve along the continuum from intuitive to scientific through three strands of internal activities: enrichment/accretion, weak restructuring, and radical restructuring (Carey, 1985; Vosniadou, 1994). *Accretion* refers to enrichment of new information or knowledge to one's existing conceptual structure (Carey, 1985; Vosniadou, 1994). It takes place as a learner accumulates more knowledge. *Weak*

restructuring is a higher level of internal process than accretion, which entails the learner to reposition concepts to form different relationships or adjust existing knowledge structure to accommodate new knowledge (Alexander, 2006; Vosniadou, 1994). Students who have incorporated energy balance into their existing knowledge base might need to reconcile it with prior knowledge which explains that body weight fluctuation is genetically determined. This reconciliation between two distinct explanations may jointly justify weight fluctuation without having one replacing the other. *Radical restructuring*, in contrast, occurs by revising and reinterpreting one's current ontological and epistemological beliefs (Vosniadou, 1994). Ontological beliefs refer to a learner's perceptions of the nature of reality; while epistemological beliefs refer to the perceptions of origin and acquisition of knowledge (Lincoln & Guba, 2000). For instance, perceiving a person whose body mass index is greater than 30 as obese reflects the scientific ontological beliefs about obesity. Also, attributing obesity to sustained duration of positive energy imbalance (i.e., energy intake exceeding energy expenditure) reflects the scientific epistemological beliefs. Taken together, accretion, weak restructuring and radical restructuring are the instrumental processes that determine and modify a learner's mental model.

As articulated above, the Framework Theory of Conceptual Change proposed by Vosniadou (1994) seems to be a potent theoretical framework to unravel how students construct essential knowledge/concepts. In her review, Ennis (2007) pointed out that students in physical education have various misconceptions in understanding fitness knowledge, motor skills, and game tactics. Identifying these misconceptions and helping

students construct scientific conceptions should become a primary focus of physical education.

Bonello (2008) in her dissertation research attempted to reveal sixth grade students' mental models of two exercise-related concepts: exercise-induced physiological change and exercise intensity. She generated data through observation, written questions, and interviews with students ($N = 18$). Identified in the evidence are five synthetic mental models of exercise-induced physiological change and three synthetic mental models of exercise intensity based on students' ontological and epistemological beliefs. For example, various perceptions of the structure of body system (ontological beliefs) and how body system functions and adapts as a result of exercise (epistemological beliefs) yielded five synthetic mental models of exercise induced physiological change. These models ranged from low-level synthetic mental models focusing on body organs (e.g., heart, lung, and muscles) functioning in responses to exercise to high-level ones indicating that physiological changes occurred at the cellular level (e.g., chemical reactions). These identified mental models have reflected developmentally distinct levels of cognitive understanding of essential knowledge/concepts in physical education.

Bonello (2008) noticed that regardless of mental model levels students attempted to seek mental coherence and avoid contradictions in constructing the models. They achieved mental coherence in a diverse and gradual fashion under the influence of various factors (e.g., school, teachers, and home). The finding suggests physical educators should take into account students' prior knowledge and individual differences and design learning experiences to induce the development of new knowledge that is

coherent because the learner is constantly seeking mental model coherence during the conceptual change process.

Learning as Behavioral Change

Learning has been traditionally defined as the relatively permanent or enduring changes in behaviors that can be observably measured (Rink, 2001; Shuell, 1986). Common behavioral change indicators emphasized in physical education classes are skills, tactics acquisition (e.g., French, Werner, Rink, Taylor, & Hussey, 1996), and moderate-to-vigorous physical activity (e.g., Corbin, 2002). Student learning, therefore, is often addressed by assessing the extent to which skills, tactics, or physical activity level improve or increase over a certain period of time. In an experiment, French and colleagues (1996) instructed ninth grade students to play badminton using three different conditions (tactics-oriented, skills-oriented, combination of tactics and skills, or control) for five lessons (55 minutes of duration for each lesson) per week for three weeks. Skill, tactics execution, and game play were measured at the end of instructions. Students from different conditions demonstrated advantages in behaviors corresponding to their treatment condition. That is, among all groups the students in the tactics condition had the highest performance in making game decisions; students in the skill condition performed best in skill acquisition. This study illustrates that skill acquisition and tactics execution are relevant behavioral change indicators that can be used as evidence of learning.

Another important behavioral change indicator in physical education is adoption of the regular physical activity behavior. Corbin (2002) posited that the ultimate goal of physical education is to foster individuals who will maintain physically active for lifespan.

The benefits of being physically active for health and quality of life are salient as revealed by empirical research evidence. These benefits from regular physical activity range from weight control (e.g., Leskinen et al., 2009) to disease prevention and treatment (e.g., Hamilton et al., 2007) and to cognitive function increase or maintenance (e.g., McDowell, Kerick, Santa Maria, & Hatfield, 2003). Because of these benefits, regular physical activity becomes an instrumental behavioral change indicator in physical education. It is suggested that physical education should strive to engage students into organized physical activities for more than 50% of the class time (USDHHS, 2000), and more importantly, should nurture “physically educated persons” who possess the competence and motivation to take part in regular physical activity on their own (NASPE, 2004).

In summary, learning as behavioral change is an essential dimension in physical education. Skill acquisition, tactics execution, and adoption of regular physical activity have been deemed as important behavioral change indicators associated with healthful living. While competence in skill and tactics takes instructional and practice time to develop; students might find it difficult to acquire new motor/sports skills in high school where instructional time is significantly reduced (see NASPE & AHA, 2010). In comparison, regular physical activity behavior, as a determinant of energy balance and obesity, appears to be a more applicable behavioral change indicator to be emphasized and monitored. Such an emphasis, along with conceptual change toward the energy-balanced living, would have the potential to reduce the ratio of overweight and obesity as students grow into adulthood.

Connection between Conceptual and Behavioral Changes

Voluntary behavior and behavioral change are driven, in part, by an individual's cognition (von Glaserfeld, 1995). Conceptual knowledge that is deeply processed by human cognition has the potential to impact and change students' physical activity patterns, as a voluntary behavior (Ennis, in press). In an intervention study, Dale, Corbin, and Cuddihy (1998) assessed the physical activity participation of ninth grade students who experienced a conceptual physical education curriculum, *Project Active Teens*, for a year. The conceptual physical education was taught for two days in a classroom and three days in a gymnasium per week. The classroom sessions focused on important concepts and benefits from physical activity and fitness; while the gymnasium sessions provided hands-on experiences of fitness self-assessment, personal program development, and lifelong physical activities. The study found that after the intervention male students significantly increased moderate physical activity and female students became significantly less sedentary than their counterparts in traditional physical education programs. The findings suggest that conceptual knowledge associated with physical activity and health helped students enhance their physical activity participation as a behavioral change. The study implies that students' cognitive processing or conceptual change should be taken into account as a contributor to developing physically active behavior and lifestyle.

The Expectancy-Value Theory

Students' conceptual and behavioral changes rely on adaptive motivation. The expectancy-value theory (Eccles & Wigfield, 1995) is the lens through which I studied

student motivation recently (Chen & Chen, 2010; Chen et al., in press). My previous study (Chen et al., in press) identified expectancy beliefs for success and subjective task values as the strongest motivators in physical education. Expectancy beliefs for success refer to the learner's judgment on how well he or she will perform in a future task; while subjective task values refer to the perceived worth that a task may provide for current and future life (Eccles & Wigfield, 1995). Three task values have been identified across academic areas and physical education: attainment value, intrinsic value, and utility value (Eccles & Wigfield, 1995; Xiang, McBride, Guan, & Solmon, 2003). Specifically, attainment value refers to the personal importance attached to doing well on a given task (Eccles & Wigfield, 1995). For example, attainment value may be perceived when students understand the importance of regular physical activity to weight management. Intrinsic value refers to the extent to which a task provides enjoyable task-learner interactive experience (Eccles & Wigfield, 1995). For example, enjoyable game playing experiences may help students recognize the intrinsic value of physical education. Utility value refers to the perceived usefulness of a task (Eccles & Wigfield, 1995). For example, the utility value of learning energy-balance knowledge lies in its potential implication for weight management. Another component in the expectancy-value theory is cost that refers to the expense or negative consequence of engaging in a task (Eccles & Wigfield, 1995). Students often come across various obstacles or difficulties in physical education classes. The negative consequence about physical activity is found as associated with the experiences in physical education such as physical discomfort, fatigue, boredom of repetitive tasks or practices, incompetent teachers, and perceived incompetence (Chen &

Liu, 2009; Xiang, McBride, & Bruene, 2006). Costs might urge students to devalue learning tasks or physical education classes.

Research in physical education has addressed how expectancy-value motivation impacts the choice, effort, performance, achievement, and affective responses among students of different levels (Chen & Liu, 2009; Gao, 2008; Gao & Xiang, 2008; Xiang et al., 2006; Zhu & Chen, 2010). For example, expectancy-value motivation is found contributing to elementary school students' intention for future physical activity participation (Xiang, McBride, & Breune, 2004) and to mastery of health-related fitness knowledge under the mediation of in-class physical activity (Chen & Chen, 2010). Many costs are present within physical education classes (Chen & Liu, 2008; 2009). The extent to which costs undermine motivation and learning remains unclear in literature. The detailed literature review on the relationship between expectancy-value motivation and outcome variables is summarized in Chapter II. These studies supported the expectancy-value motivation as one of the most relevant motivation constructs in addressing students' conceptual and behavioral changes.

“Warm” Conceptual Change

Conceptual change from intuitive mental models to scientific mental models demands a high level of content engagement in the learning process. Pintrich, Marx, and Boyle (1993) classified the existing conceptual change literature as “cold conceptual change” due to the fact that motivation was not incorporated as an underlying factor. They argued that hardly do students activate or transfer knowledge automatically; instead, motivational constructs such as goals, values, self-efficacy, and control beliefs are

potential mediators of conceptual change and should be studied thoroughly (Pintrich et al., 1993). Similarly, Dole and Sinatra (1998) argued that motivation is crucial for conceptual change. Motivation not only instigates the learner to approach and interact with the new conceptions, but also increases the level of metacognitive engagement underlying conceptual change.

My Preliminary Studies

This dissertation research is a continuation of my current research studies focusing on student motivation and learning in physical education. In the past three years, I have conducted three studies that are conceptually cohesive in which motivation and its functions in physical education were systematically examined. These three studies have built foundations for the dissertation research. In the following section, I will present the three completed studies as core literature and then will attempt to elucidate the research questions to be addressed in the current study.

My first research inquiry was to address the extent to which K-12 students in physical education are motivated, and to what extent motivation was associated with learning outcomes (Chen et al., in press). Using the meta-analysis approach I synthesized the level of K-12 students motivation measured in 79 published studies. The motivation constructs include five major motivation theories (i.e., achievement goal orientations, expectancy-value, interest, self-efficacy, and self-determination). Motivation means were standardized and aggregated to address students' motivation magnitude. The study found that in general K-12 students in physical education are motivated regardless of theoretical frameworks used in the studies. The aggregated motivation mean for all students was

65.47 on the scale of 100, ranging from 40.69 for self-efficacy to 80.19 for expectancy beliefs for success. While various strong motivators were identified in the study; students' motivation stemmed from their expectancy beliefs for success and subjective task values was the strongest. The second major finding from this study is that about a third of the included studies ($N = 29$) collectively showed that the correlation effect sizes for the relationship between motivation and learning outcomes were low, $\bar{r} = .20$ for competence-based outcomes; $\bar{r} = .30$ for non-competence-based outcomes. The research findings from this study have significant implications to future research and practice in physical education. Specifically, the findings support and advocate a stronger emphasis on providing meaningful and challenging content so that motivated students will learn and achieve. More curricular and instructional efforts should be devoted to connecting student motivation to learning, competence-based learning in particular, in physical education. Moreover, the study portrayed a holistic picture for me to continue studying student learning and motivation. It has highlighted the necessity and potential to investigate the impact of expectancy-value motivation in relation to learning outcomes in physical education.

In the second research inquiry (Chen & Chen, 2010), I explored the relationships among expectancy-value motivation, students' learning of health-related fitness knowledge, and in-class physical activity. The purpose of this study was to investigate the effect of expectancy beliefs and subjective task values on knowledge construction in classes with different levels of physical activity intensities. Data for expectancy-value motivation, health-related fitness knowledge, and in-class physical activity intensity were

collected among 753 elementary students from 12 schools (3rd Grade: $N = 243$; 4th Grade: $N = 243$; 5th Grade: $N = 257$). Due to the nested data structure, the hierarchical linear modeling was used for data analysis. Specifically, the variables of expectancy-value motivation and health-related fitness knowledge were analyzed at the student level and physical activity was analyzed at the class level. The study revealed that in-class physical activity negatively mediated attainment value influence on knowledge learning. It means that a learning context with moderate physical activity needs to be present in order to translate students' perception of importance regarding physical education into behavior of constructing health-related fitness knowledge. The study also found that higher in-class physical activity intensity facilitated knowledge learning. Nevertheless, this finding should be interpreted in conjunction with the first finding; that is, moderate in-class physical activity seems to be most desirable when the instructional objective is to promote knowledge learning and connecting it with students' perceived task values. This study generated preliminary evidence to support that the connection between expectancy-value motivation and knowledge learning in physical education should be studied with the presence of physical activity.

In the third study, I explored elementary school students' longitudinal changes in motivation and knowledge (Chen et al., 2011). A total of 670 third ($N = 329$) and fourth ($N = 341$) grade students from 13 schools provided data for variables of expectancy-value motivation and health-related fitness knowledge once per semester for four consecutive semesters. The repeated measure MANOVA was used for data analysis. The study found that although elementary school students maintained relatively high scores on

expectancy-value motivation (means ranging from 3.93 to 4.56 on a 5-point Likert scale), the scores on the task values decreased steadily from the first to the fourth semester (large effect size η^2 ranging from .11 for perceived attainment value to .16 for perceived utility value). This finding illustrates that students at a young age tend to have strong appreciation of values about physical education content; however, the appreciation declines over time with an increase in experiencing the content. In addition, despite the non-significant increasing curve, student performance in knowledge tests maintained at the moderate level over time. The findings provoke future studies with longer tracking period to understand the connection between expectancy-value motivation and knowledge learning. Moreover, due to the potential effect of physical activity on the connection between expectancy-value motivation and knowledge learning (Chen & Chen, 2010), future research should investigate the extent to which physical activity would bear upon this connection.

Statement of the Problem

The above literature summary (see Chapter II for detailed review) suggests a need to study learning in physical education defined as both conceptual and behavioral change. The summary illustrates two gaps in the literature which may be bridged by this dissertation research. Gap One, conceptual change should be an integral part of definition of learning in physical education as demonstrated in a previous study (Bonello, 2008). To understand the process of conceptual change as an outcome of the learning process in physical education, it has to be studied with learner motivation so as to understand the mental models from a “warm” changing perspective (Dole & Sinatra, 1998; Pintrich et al.

1993). Gap Two, energy balance is an important concept to learn in physical education. Presumably, the decade-long emphasis on fitness education in our schools has raised strong awareness of the need to change physical inactivity behaviors based on an understanding of the concept. Curriculum theorists (e.g., Ennis, 2007) and constructivist psychologists (e.g., von Glaserfeld, 1995) believe that behavioral change might stem from conceptual change. However, evidence is needed in physical education research to validate this theoretical observation. As an attempt to bridge the gaps, the purpose of this dissertation research was to identify the extent to which expectancy-value motivation, energy-balance concept (as manifested in mental models), and physical activity behavior interacted with each other.

Research Questions

The existing literature gaps and my previous studies have provoked conceptualization for this dissertation research. My preliminary studies pinpointed expectancy-value motivation as the strongest motivators (Chen et al., in press) that contributed to health-related fitness knowledge under the mediation of in-class physical activity (Chen & Chen, 2010). Other studies also articulated motivation as a necessary component for conceptual change (Dole & Sinatra, 1998; Pintrich et al. 1993), and knowledge as an influential factor for behavioral change (e.g., Contento et al. 2010). To further identify the interactive relation among the variables, this research addressed the following research questions: (a) To what extent did expectancy-value constructs affect energy-balance knowledge, in-class and after-school physical activity? (b) To what extent did ninth graders construct their mental representations about energy-balance knowledge?

and (c) To what extent did their mental representations developed in health education affect physical activity behavior in physical education and after-school hours?

Research Hypotheses

To answer the research questions, I examined the following hypotheses. Figure 1 presents the *a priori* path diagram with the hypothesized path relationships. First, prior

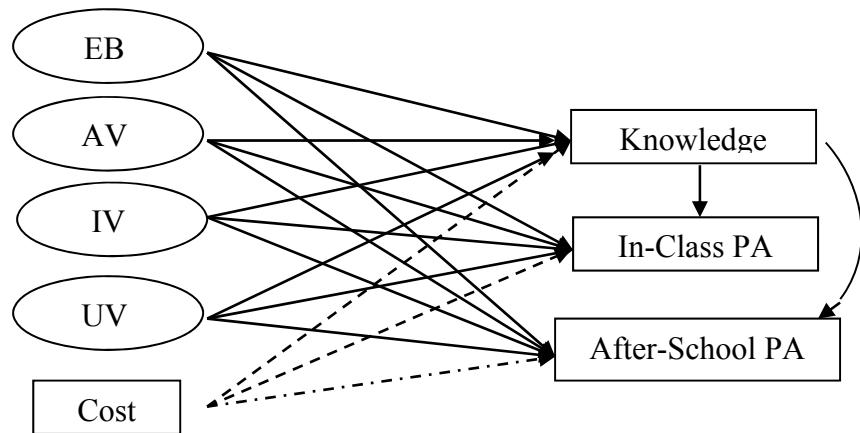


Figure 1. The *a priori* Path Diagram. Solid lines signify positive paths. Broken lines signify negative paths. EB: Expectancy beliefs for success; AV: Attainment value; IV: Intrinsic value; UV: Utility value; PA: Physical activity

research postulated that motivated learners tend to revise or re-interpret their current conceptions of knowledge/concepts (Dole & Sinatra, 1998; Pintrich et al., 1993). Similarly, motivated learners tend to show more choice, effort and persistence in participating in various physical education tasks (Chen & Ennis, 2004; 2009). Hence, it was hypothesized (a) that students who have higher expectancy beliefs for success, subjective task values, and lower costs would demonstrate better understanding of energy balance and higher level of in-class and after-school physical activity than the less motivated students. Second, conceptual understanding was believed to be transforming

from intuitive to scientific mental models in schooling (Vosniadou, 1994). It was hypothesized (b) that the students would hold mental representations about energy-balance knowledge at various developmental stages. Third, deeper understandings of essential knowledge are documented to be contributing to changes in health-related behaviors (Contento et al., 2010; Dale et al., 1998). It was further hypothesized (c) that the scientific mental representations would be associated with high level of physical activity in physical education and after-school time.

Significance of the Research

The dissertation research aimed to articulating the relationships among motivation, knowledge, and physical activity. It has theoretical and practical significance. First, identifying the effect of expectancy-value motivation on energy-balance knowledge and physical activity may contribute to the literature of motivation. This study will provide empirical evidence about the implication of expectancy-value constructs for conceptual and physical learning measures in physical education. Second, this research takes the initiative to emphasize conceptual change as an underlying factor for healthful behavioral change. The perspective of conceptual change will offer new meaningful insights for student learning in physical education. It may help physical education professionals approach the issue of physical activity promotion by identifying the function of conceptual understanding.

Definitions of Key Terminologies

Accretion refers to knowledge enrichment in the cognitive structure (Carey, 1985).

Achievement goals are conceptualized as purposes of achievement behaviors that guide the way the learner approaches, engages in, and responds to achievement tasks (Dweck & Leggett, 1988).

Attainment value refers to the personal importance attached to doing well on a given task (Eccles & Wigfield, 1995).

Concept cluster refers to a group of the same or similar concepts gathered or occurring closely together (The American Heritage Dictionary of the English Language, 2000).

Concept proposition refers to the relationship between two concepts with a labeled relational explanation (McClure, Sonak & Suen, 1999).

Conceptual change refers to the revisions in personal mental representations that are often precipitated by purposeful educational experiences (Murphy & Mason, 2006).

Concept-mapping is a graphical tool for organizing and representing knowledge, which includes listing concepts and linking the relationships between concepts (Novak & Canas, 2008).

Cost refers to the expense or negative consequence of engaging in a task (Eccles & Wigfield, 1995).

Domain refers to the formalized body of knowledge such as mathematics, science, and physical education (Alexander, 2006).

Energy balance refers to the balanced formula between energy intake through food and beverage and energy expenditure through body functions and physical activity (Dunford, 2010).

Epistemological beliefs refer to the perceptions of origin and acquisition of knowledge (Lincoln & Guba, 2000).

Expectancy beliefs for success refer to the learner's judgment on how well he or she will perform in an upcoming learning task (Eccles & Wigfield, 1995).

Individual interest refers to an individual's psychological disposition that guides personal preferences for activities/action (Hidi, 2000).

Interest is a psychological state characterized by a high level of attention, intensive effort, and prolonged engagement in an activity accompanied by feelings of pleasure and a sense of achievement (Hidi, 2000).

Intrinsic motivation refers to people's drive to undertake an activity for its inherent interestingness or enjoyment (Deci & Ryan, 1985).

Intrinsic value refers to the extent to which a task provides enjoyable task-learner interactive experience (Eccles & Wigfield, 1995).

Mental model refers to the special mental representation, generated during cognitive functioning, whose characteristics are structured in a way for the model to preserve the structure of the external phenomenon (Vosniadou, 1994)

Motivation refers to “the process whereby goal-directed activity is instigated and sustained” (Pintrich & Schunk, 2002, p. 5).

Obesity is a state in which an individual has body fat in amounts far exceeding biological need, and is often the result of a small but chronic positive energy imbalance over prolonged period of time (Jeffery & Harnack, 2007)

Ontological beliefs refer to a learner's perceptions of the nature of reality (Lincoln & Guba, 2000).

Radical restructuring refers to the substantial changes in the learner's fundamental paradigm to reach a higher level of understanding (Carey, 1985).

Self-efficacy refers to judgments of the likelihood that one can organize and execute courses of action required to deal with prospective situation (Bandura, 1980).

Situational interest refers to the appealing effect of an activity or object that triggers attention and engagement from an individual at the moment of person–activity interaction (Hidi, 2000).

Task values refer to the perceived worth that a task may provide for current and future life (Eccles & Wigfield, 1995).

Utility value refers to the perceived usefulness of a task (Eccles & Wigfield, 1995).

Weak restructuring refers to the early stage of accommodation which incorporates the new information into the existing cognitive structure (Carey, 1985).

Zone of the proximal development refers to the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978).

CHAPTER II

REVIEW OF THE LITERATURE

Energy-balanced living is essential to overweight/obesity prevention and management. In developed societies where excessive energy intake is prevalent, it has become imperative to educate young generations the knowledge, skill, and strategies to live an energy-balanced life. With this rationale, this dissertation research aimed to determine the extent to which ninth grade students understood energy-balance knowledge in relation to their motivation in physical education, and physical activity behavior in physical education and after-school hours. In the following sections, I first reviewed literature about energy balance as the important healthful-living knowledge. It is important to review the literature because energy-balance knowledge is a crucial component in physical education and/or health education content. Second, I reviewed the literature of modern learning perspectives. It was assumed that adolescents had various degrees of understanding of energy intake and expenditure. Reviewing the learning theories helped me understand various ways in which the knowledge was learned, stored, and organized in students' knowledge repertoire. Third, I reviewed the literature on achievement motivation theories with a particular focus on the expectancy-value theory. Motivation is a critical component in learning and behavior change. Research findings from education and physical education suggest that without motivation, learning and behavior change can be regarded as a "cold" process where effectiveness of learning

and achievement are reduced (Pintrich et al., 1993). By reviewing the above literature, I identified the theoretical gaps that needed to be filled in relation to the purposes of the dissertation research.

Energy Balance and Healthful Living

Definition of Energy Balance

Energy balance occurs when energy intake equals energy expenditure (Dunford, 2010). The common sources of energy are carbohydrate, protein, fat and alcohol contained in the food and/or beverages that people intake on a daily basis; while the ordinary channels for energy expenditure are through physical activity, metabolism, and the digestion of food (Dunford, 2010). When the amount of energy intake is unequal to that of energy expenditure, energy imbalance will occur. Mathematically, 3500 to 4000 Kcal of energy is equivalent to the amount of energy that one pound of body fat could produce (Dunford, 2010; Katz, 2010). In reality, positive energy imbalance, when energy intake exceeds energy expenditure, will give rise to accumulation of body fat; whereas negative energy imbalance will lead to fat reduction. In the modern automated and affluent societies, it is easy to gain and maintain the state of positive energy imbalance (Katz, 2010; Hamilton et al., 2007; Wright et al., 2004). The energy surplus due to positive energy imbalance becomes the proximal cause of overweight and/or obesity (Katz, 2010).

Implications of Energy Balance

The energy- balance knowledge has significant implications for the effort of addressing the obesity issue in the adolescent population. Multiple school-based

intervention studies on obesity prevention or control revolved around the intentional attempts leading to negative energy imbalance. Negative energy imbalance has been facilitated by physical activity promotion and educational models for behavior modification, or combination of the two. The prolonged period of negative energy imbalance, in turn, has led to weight reduction. In a review article, Shaya, Flores, Gbarayor, and Wang (2008) synthesized 51 school-based interventions that were published between June 1986 and July 2006. The study found that of the 51 included intervention studies, 15 utilized physical activity programs, 16 utilized educational models, and 20 combined the two as intervention strategies. The majority of these programs (i.e., 13/15 physical activity programs, 12/16 educational programs, and 15/20 combination programs) demonstrated significant effects on weight loss. Body weight measured by body mass index (BMI) and skin-fold were reduced significantly due to the interventions.

In another important study, Katz, O'Connell, Njike, Yeh, and Nawaz (2008) conducted the systematic review on 19 school-based intervention studies, eight of which were included in the meta-analysis of the intervention effect. These intervention programs were characterized by nutritional knowledge and behavior, physical activity, reduction in television viewing, or any combinations of above. The included studies were selected from the pool of publications related to obesity intervention between 1966 and October 2004, which studied student participants from ages of three to 18. The meta-analytic results found that nutrition and physical activity interventions resulted in significant weight reduction in comparison with control (Standardized mean difference =

-.29, 95% confidence interval = -.45 - -.14). Thus, the finding recognized nutrition and physical activity as effective intervention strategies for weight reduction in school settings.

Relevancy of the Findings to the Dissertation Research

As shown in the above two comprehensive reviews (Katz et al., 2008; Shaya et al., 2008), the essence of many obesity intervention studies was to target and manipulate the equation of energy balance. Either through directly changing participants' behaviors or by presenting a stimulating environment in which behaviors were shaped indirectly, these intervention programs managed to create the prolonged state of negative energy imbalance and then led to weight reduction. Although these studies collectively demonstrated effectiveness of interventions, it remains unknown whether adolescents are able to construct the scientific conceptions of energy balance to sustain changes in eating and physical activity behaviors that allow continued development of healthful living behavior. Additional research on students' learning of energy-balance knowledge and its function on behavior change are needed.

Learning Theories

To understand students' energy-balance knowledge and energy-balanced behaviors, it is necessary to elaborate the definitions and scopes of learning. Three major learning theories documented the literature in education and physical education: the behaviorism theory (Thorndike, 1911/1965), the information-processing theory (Lachman, Lachman, & Butterfield, 1979), and the constructivist theory (Piaget,

1926/1930; Vygotsky, 1978). Each of these learning theories was reviewed and critiqued in the following paragraphs.

The Behaviorism Theory

The behaviorism theory, established from laboratory animal experiments, has achieved predominance in education during the first half of the 20th century (Mayer, 1996). The tenet of this perspective is to acquire desired behaviors via the stimulus-response contingency (Skinner, 1968; Thorndike, 1911/1965). The contingency is often established by attaching a desired behavior with a consequence (Skinner, 1968). The nature of the consequence determines the prospect of a behavior; that is, behavior is reinforced as a result of a positive consequence (i.e., reward) or weakened as a result of an aversive consequence (e.g., negative reinforcement, punishment) (Skinner, 1968). The educational implication of this perspective is to shape or modify students' classroom or gymnasium behaviors by assigning certain consequences at the teacher's end (Alexander, 2006). Teachers often dispense reinforcement and/or punishment to student behaviors; while students practice repeatedly on basic skills/drills until the desired behaviors are explicitly shown in a consistent manner.

In physical education, physical activity is a desired behavior that has been emphasized over the past two decades. McKenzie, Sallis, Kolody, and Faucette (1997) investigated the effects of a behaviorism-themed curriculum on physical activity promotion. The *Sports, Play, and Active Recreation for Kids (SPARK)* curriculum was designed to increase elementary school students' enjoyable physical activity in physical education. Physical activity and other behaviors were measured and compared across two

treatment conditions, namely, physical education specialists ($n = 32$) and classroom teachers ($n = 38$) who received the *SPARK* curricular training, and one control group of teachers ($n = 33$). A standardized observation instrument, *System for Observing Fitness Instruction Time*, was utilized to measure and record the intensity, duration of physical activities, and teacher and student behaviors. The analysis of variance (ANOVA) and Tukey's LSD Multiple Comparison were conducted to test the group differences in physical activity and other behaviors. It was found that the lessons taught by physical education specialists were significantly more physically active than those taught by trained classroom teachers and by teachers in the control group ($p < .001$), and that the lessons taught by trained classroom teachers were significantly more active than those taught by teachers in the control group ($p < .001$).

In the *SPARK* curriculum (McKenzie et al., 1997), the behaviorism approaches were explicit. The educational contexts and teacher behaviors in the two treatment conditions were purposefully presented to reinforce occurrence of the desired behavior - physical activity. The increased level of physical activity, as the result, was successfully manipulated. However, it should be recognized that students' voices in the learning process were often silenced or neglected in these behaviorism-themed curricula. In today's physical education, merely focusing on the physical dimension does not suffice to foster the "physically educated" persons (NASPE, 2004). Perspectives from other learning theories should be incorporated to more thoroughly understand and study teaching and learning in physical education. In this dissertation research, I emphasized students' in-class and after-school physical activity and conceptual understanding of

energy balance. The behaviorism learning theory provided informative insights to help me examine the physical dimension of learning but did not address the cognitive dimension of learning.

The Information-Processing Theory

The information-processing theory postulated that human brain works in analogy with an electronic computer which inputs, encodes and processed information, and then output an action (Lachman et al., 1979). The information-processing theory appeared in the late 1950s and gradually replaced the behaviorism as the dominant perspective in psychology and education (Mayer, 1996). By this theory, teachers dispense information (e.g., knowledge, skills) to students who input, encode, process, and memorize it (Mayer, 1996). The information is processed in cognition at three sequential stages: working memory, short-term memory, and long-term memory (Gagne, 1977). Along the learning process, only when the information reaches and retains in the long-term memory becomes knowledge (Gagne, 1977). Common instructional approaches in a classroom or gymnasium are lecturing, modeling or demonstration, and feedback. By the information-processing theory, teachers are expected to become knowledgeable and skillful in many aspects; while students would imitate and reproduce these knowledge and skills through the gradually enhanced mechanism of information processing.

The information-processing theory has far-reaching influence on the research area of motor behaviors which is closely relevant to the research and practice of physical education. For example, French, Rink, and Werner (1990) conducted an empirical study to investigate the effects of contextual interference on skill acquisition and retention.

Three experienced physical educators taught volleyball forehand pass, serve, and set to ninth grade students ($N = 139$) for nine lessons. Students were randomly assigned into three equal-sized experiment conditions: blocked, random, or block-random. In the blocked condition, one skill was practiced repeatedly in three days before moving onto the next two skills, each for three days. In the random condition, the three skills were practiced in an order that no skill was performed more than twice consecutively. In the random block condition, one skill was practiced in a block schedule in the first day, and all three skills were practiced randomly in the following two days. The ANOVA found that skill acquisition and retention for forehand pass, serve and set were all significant over time (Set: $F = 6, p < .05$; forearm pass: $F = 4.54, p < .05$; serve: $F = 8.81, p < .05$), but were not significant across practice conditions.

As such, the research in motor learning and control has involved the information-processing learning theory in which skill acquisition and retention are the focused variables. Similar to the behaviorism theory, students' agency seems to be absent. However, the information-processing theory distinguishes itself from the behaviorism in that cognition is taken into account in the learning process. That is, learners input and process external information and then generate actions as output. Specifically, students in the French et al. (1990) experiments practiced their volleyball skills under different conditions and acquired, retained these skills over time. The improved volleyball skills could be interpreted that students' information processing has increased accuracy and efficiency as their motor programs became more sophisticated from practice (Schmidt & Wrisberg, 2008). Thus, the information-processing theory seems to be one step further

than the behaviorism in explaining student learning by recognizing the influence of cognition in behavioral or physical changes. However, theories with an emphasis on learners' agency in the learning process that involves meaningful decision-making and/or problem-solving in a social environment are needed.

The Constructivism Theory

Emerged with popularity in the late 1970s, the constructivism theory proposed learning as a process of knowledge construction. Students construct actively new knowledge by building it upon the basis of existing knowledge (Piaget, 1926/1930; Vygotsky, 1978). Knowledge construction occurs individually and/or socially. The individual constructivists believe that students assimilate and incorporate new information into the current cognitive structure so that a new dynamic equilibrium is achieved (Piaget, 1926/1930). In this regard, knowledge construction is an idiosyncratic process where external environment can bear limited influences. In comparison, the social constructivist theory emphasizes social interaction as the core vehicle for cognitive development and learning. With guided participation and scaffolding by the more knowledgeable peers and teachers, students could engage in discoveries, gain meaningful understandings, and approach the *zone of proximal development* (Hausfather, 1996). *Zone of the proximal development* refers to “the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” (Vygotsky, 1978, p.86).

The constructivist learning theory has been studied in physical education. For example, Zhu and colleagues (2009) examined the extent to which cognitive engagement and situational interest contribute to knowledge achievement in a constructivism-themed curriculum. The curriculum incorporated fitness knowledge and its benefits to health into physical activities. A workbook that helped students, as junior scientists, to collect data (e.g., heart rate) and solve problems was utilized to assess cognitive engagement; while a pre- and post-test measure assessed knowledge achievement from the curriculum. A total of 670 third grade students from 13 randomly selected urban elementary schools contributed data on measures of situational interest, performance on solving workbook problems, and knowledge achievement. The study found that the performance on solving workbook problems contributed to knowledge achievement; while skipping workbook tasks had stronger negative impact on knowledge achievement than performing the tasks incorrectly. These findings suggested that students constructed new knowledge through interacting with meaningful cognitive tasks.

In this study (Zhu et al., 2009), students were afforded the agency in participating in the organized physical and cognitive activities. The students played the role of junior scientists who were engaged in the full cycle of scientific inquiry in solving practical physical activity problems from forming hypothesis, making predictions, to collecting evidence, examining results, and reaching conclusions. During the problem-solving experiences, students were urged to connect new essential knowledge with their authentic physical experiences, from which meaning or relevance was formulated. Students' prior knowledge was assessed as building blocks for constructing new knowledge. Unlike the

curricula themed by the behaviorism or information-processing theories, the constructivist curricula are often perceived as interesting, important, and useful by students (e.g., Ennis, 2008). Thus, the emphases on learners' agency, prior knowledge, and perception of meaningfulness in the process of knowledge construction are the outstanding characteristics of the constructivist learning theory. The constructivist learning theory seems a more plausible lens than the behaviorism and information-processing theories to examine learning from students' perspective with which motivation, prior knowledge and the learning context are often studied.

Integration of the Three Learning Theories

Taken together, learning has been informed by the behaviorism, information-processing, and constructivism theories in the literature. Each perspective has its legacies and limitations. Each theory has gained prevalence at different times among researchers and practitioners. The influences brought out by these theories are far-reaching even to the contemporary education and physical education. Being interested in studying student learning, I have formulated my personal lens to understand and study learning in physical education. By and large, I deem learning as conceptual change and behavioral change in the domain of physical education. These two dimensions of learning crossed the boundaries of the three major theories and absorbed characteristics of each theory. In the following paragraphs, I elaborated conceptual and behavioral changes as my lens to studying student learning in this dissertation research.

Learning as Conceptual Change

The constructivist learning theory emphasizes the active role of learners who interpret, rather than passively internalize, the new external information on the basis of what they already know (Murphy & Mason, 2006). This active process of interpretation could be characterized by conceptual change which refers to the revisions in personal mental representations that are often precipitated by purposeful educational experiences (Murphy & Mason, 2006). Ennis (2007) pointed out that students in physical education have misconceptions in understanding fitness knowledge, learning motor skills, and making tactical decision in game situations. Thus, helping students engage conceptual change and correct these misconceptions appears to be a meaningful goal of physical education.

Framework theory of conceptual change. Vosniadou (1994) established the *Framework Theory of Conceptual Change*. A major characteristic of the framework is that external objects, including knowledge, could be represented in one's mental structure and these mental representations are mental models. Mental models could evolve along a continuum from the intuitive to scientific models through three strands of internal activities: *enrichment*, *weak restructuring*, and *radical restructuring*. *Enrichment* refers to accumulation of new information or knowledge to one's existing conceptual structure. *Weak restructuring* requires the existing conceptual structure to be reshaped or adjusted in some manner so that it could reconcile with the newly enriched knowledge. *Radical restructuring*, in contrast, occurs only when revision in one's current ontological and epistemological beliefs takes place. *Ontological beliefs* refer to a learner's perceptions of

the nature of reality; while *epistemological beliefs* refer to the perceptions of origin and acquisition of knowledge (Lincoln & Guba, 2000).

The Framework Theory of Conceptual Change has theorized coherently the way that learners construct new knowledge on the basis of the existing knowledge. It is a powerful theoretical framework in articulating student learning at distinct developmental stages. It has integrated the characteristics of the information-processing theory (e.g., information input or enrichment) and the constructivism theory (e.g., connection between prior and new knowledge). This integrated perspective has allowed me to study physical education learning with a more comprehensive stance.

FTCC in science education. Empirically, Vosniadou and Brewer investigated children's mental models of the shape of the earth (1992) and the day/night alteration (1994). In Vosniadou and Brewer (1992), 60 students (First grade: $n = 20$; Third grade: $n = 20$; Fifth grade: $n = 20$) were interviewed to answer questions regarding the shape of the earth. During the interviews, children verbalized the shape of the earth based on their current knowledge and beliefs; while the option of drawing pictures was suggested when it was hard to describe by words. Students' responses were coded numerically following a scoring key established and validated prior to the study. From the data, five synthetic mental models of the shape of the earth were identified: the disc earth, the dual earth, the hollow sphere, and the flattened sphere. To compare by age, the older students had synthetic mental models closer to the scientific conceptions than the younger students. It was believed that students' mental models were heavily constrained by current ontological and epistemological presuppositions.

In their subsequent study, Vosniadou and Brewer (1994) examined children's mental models of the day/night alteration, a more complex science concept that needed to consider the relations between the moon, the sun, and the earth. The participants for this study were the same children who participated in their previous study (1992). With a similar research design, this study revealed 16 mental models of the day/night alteration. It was found that the younger students formulated intuitive mental models which were based on everyday experience (e.g., the sun goes down behind mountains); while the older students constructed synthetic mental models (e.g., the sun and the moon revolve around the stationary earth every 24 hours) or scientific mental models. The findings suggested that the development of mental models was subject to students' age and previous exposure to the scientific conceptions of the phenomena. Younger students who were also less knowledgeable about the scientific knowledge tended to be the ones who had intuitive mental models or less sophisticated synthetic mental models; while older students with more exposures to the scientific conceptions constructed more advanced synthetic and, for a few students, scientific mental models.

As shown above, the Framework Theory of Conceptual Change was supported with empirical evidence. It has provided an alternative perspective from which student learning can be understood and studied. It is acknowledged that learners have mental models of external objects, events and phenomena, and these mental models can transform or evolve from developmentally stages when new information is exposed. The mental models can categorically represent the levels of conceptual understandings or stages of learning achievement. The Framework Theory of Conceptual Change turns out

to be a viable theoretical framework for me to understand ninth grade students' knowledge associated with energy balance.

Conceptual change in physical education. Ennis (2007) advocated the perspective of conceptual change to foster "a sound mind in a sound body" (p. 139). In reviewing previous research, Ennis summarized that students held misconceptions in many case scenarios which ranged from making tactically inappropriate decisions (e.g., throw a uncatchable pass; Rovegno, Nevett, Brock, & Babiarz, 2001), performing poorly in learning motor skills due to ineffective cognitive response selection (e.g., McPherson, 1999; McPherson & Thomas, 1989), to equating fitness with "looking good" or "being thin" (Placek et al., 2001). As such, Ennis (2007) asserted that conceptual change entails more than just teachers transmitting the culturally accepted knowledge or skills to the students. Restructuring, especially radical restructuring, in one's knowledge structure may be necessary in order to replace these misconceptions with the scientific conceptions. Ennis further reasoned that radical restructuring may be a necessary condition for major transformations in behaviors such as changing sedentary lifestyle into regular physical activity.

Bonello (2008) in her dissertation research attempted to reveal six grade students' mental models of two exercise-related concepts: exercise induced physiological change and exercise intensity. Bonello generated data through observation, written questions, and interviews from students ($N = 18$). Identified from the data were five synthetic mental models of exercise induced physiological change, and three synthetic mental models of exercise intensity based on students' ontological and epistemological beliefs. For

example, sixth grade students' perceptions of the body system structure (ontological beliefs) and functions and adaptations (epistemological beliefs) yielded five synthetic mental models of exercise induced physiological change. Bonello revealed a lower-level synthetic mental model. This less sophisticated conception attributed the sequential chain of physiological events to meet the increased need for oxygen during exercise to separate functions off independent body organs (e.g., heart, muscles). More advanced mental models were identified in the study as well. For example, a higher-level synthetic mental model described the same physiological changes observed in exercise at the cellular level (e.g., chemical reactions). These identified mental models have reflected developmentally distinct levels of cognitive understanding of essential knowledge/concepts in physical education.

Bonello's study (2008) has provided deep, meaningful understandings of student learning in physical education. The findings supported the tenability of Framework Theory of Conceptual Change in addressing student learning in the domain of physical education. In addition, the presence of mental models implied that students attempted to seek mental coherence and avoid contradictions in cognitive functioning. This state of mental coherence was achieved in a diverse and gradual fashion and mediated by various factors (e.g., school, teachers, and home). These findings are significant for educators who strive to help students construct scientific mental models that reflect mastery of essential knowledge/concepts in physical education. The findings suggest that conceptual change is an uneasy process. The existing knowledge structures may be in a coherent state. To break the coherent equilibrium of students' naïve or initial mental models,

teachers need sound strategies to lead students to where radical re-structuring mental models will take place. In summary, learning as conceptual change is a legitimate and informative perspective to understand and study student learning in physical education.

Learning as Behavioral Change

Learning has been traditionally defined as the relatively permanent or enduring changes in behaviors that can be explicitly measured (Rink, 2001; Shuell, 1986). In physical education, typical behavioral change indicators are motor/sport skills, tactics (e.g., French et al., 1996) and physical activity (e.g., Corbin, 2002). The extent to which these behavioral indicators change over time in an educational setting reflects the process of learning.

In an experiment, French and colleagues (1996) examined the effects of three different instructional approaches on the badminton tactics and skills. Ninth grade students ($N = 48$) were randomly assigned into the three treatment conditions or the control condition to learn and practice badminton. Specifically, these groups were taught by four different teachers who were trained to teach badminton with emphasis on tactics, skills, combination of the two, or neither of the two. The badminton classes were taught three times per week with 55 minutes of duration for five weeks. Skill and tactics executions during testing sessions and game play were measured and compared across groups. It was found that the skill, tactical, and combination groups exhibited significantly better performance than the control group on the tactics execution and some measures of skill execution during game play; while the effects across the three treatment groups seemed blurry. This study illustrates that students' performance behavior do

change as a result of learning in an instructional environment where performance and tactical behavior change is the goal.

Physical activity is another important behavioral change indicator in physical education. Corbin (2002) asserted that an ultimate goal of physical education is to foster life-long physical activity. Tremendous efforts have been devoted to promoting students' physical activity level both in and out of physical education classes (see a collection of studies in Katz et al., 2008; Shaya et al., 2008). Physical activity as the behavioral change indicator has been measured in many studies. For example, McKenzie et al. (2006) assessed female students' physical activity in middle school physical education as it related to the contextual (i.e., field site, lesson context and location, class composition) and teacher characteristics (i.e., gender). Female students ($N = 431$) randomly selected from 36 public middle schools in diverse geographical areas in a physical activity intervention program contributed data to the study. The *System for Observing Fitness Instruction Time* was utilized to measure the type and duration of physical activity students participated in. It was found that the average proportions of lessons spent in moderate-to-vigorous physical activity and vigorous physical activity were 37.9% ($SD = 18.5\%$) and 13.1% ($SD = 11.7\%$). Variations in the proportion of moderate-to-vigorous physical activity and/or vigorous physical activity existed across field sites (Vigorous physical activity: $p < .004$) and lesson location (Moderate-to-vigorous physical activity: $p < .001$; vigorous physical activity: $p < .001$).

Similar to an earlier study (McKenzie et al., 1997), this study (McKenzie et al., 2006) assessed students' physical activity within a highly controlled curricular and

instructional context. Physical activity promotion, as the sole direct purpose of these physical education programs, was clearly an indicator of behavioral change. Moreover, empirical studies that focused on physical activity as an essential byproduct along educational physical education programs are also available. For example, Chen, Martin, Sun, and Ennis (2007) investigated the possibility of reduced physical activity as a result of learning in a constructivist physical education curriculum. An experimental design was used to compare the impact on physical activity between a constructivist curriculum ($n = 84$) and a multi-activity curriculum ($n = 78$). The RT3 accelerometers (Stayhealthy, Inc., Monrovia, CA) measured and recorded students' physical activity and caloric expenditure (metabolic equivalent, or MET, as unit of energy). It was found that students from in the constructivist learning condition received a similar amount of physical activity as their counterparts in the control condition (MET = 2.6 for experimental; MET = 2.5 for comparison, $p = .30$). The finding suggests that a constructivist, concept-based physical education is able to provide similar amount of physical activity to elementary school children.

In summary, skill acquisition, tactics execution, and moderate-to-vigorous physical activity have been deemed as important behavioral change indicators in nurturing the “physically educated” persons (NASPE, 2004). From the above empirical studies (Chen et al., 2007; McKenzie et al., 1997; 2006), it is apparent that physical activity as a behavioral change indicator has been studied as both a direct and indirect learning outcome of physical education. Physical activity can be measured by several different ways such as systematic observation (e.g., System for Observing Fitness

Instruction Time), sensor-based technology (e.g., accelerometers and pedometers), and self-report (e.g., Three-Day Physical Activity Recall, Weston, Petosa, & Pate, 1997).

These studies have helped us understand how physically active students are and should be in and out of physical education classes. Using these behavioral indicators may help us determine not only the health benefits students receive but also their learning achievement.

Bridging Conceptual Change with Behavioral Change

It is believed that behavior and behavioral change are driven, in part, by an individual's cognition (von Clasersfeld, 1995). Conceptual knowledge that is deeply processed by human cognition has the potential to impact and change students' physical activity patterns, as a behavioral change (Ennis, in press). However, limited empirical evidence has confirmed or disconfirmed it in physical education. Dale et al. (1998) investigated the physical activity level of students one to three years after they had been exposed to a ninth grade conceptual physical education curriculum. The intervention lessons were taught for two days in a classroom and for three days in a gymnasium. The classroom sessions taught important concepts and facts about physical activity and fitness; while the gymnasium sessions taught fitness self-assessment, personal program-building skills, and methods for performing a variety of lifelong physical activities. The ninth grade students who originally participated in the one-year long *Project Active Teens* ($n = 213$) were compared to the ninth grade students who participated in a traditional multi-activity physical education ($n = 104$). A self-report questionnaire (i.e., the physical activity question items from the *Youth Risk Behavior Survey*; Health, Pate, & Pratt, 1993)

was used to measure students' physical activity. It was found that one year after the intervention the proportion of male students in the treatment group who participate in moderate physical activity for more than five days per week was significantly higher than those in the control group (34% vs 13%, $p = .04$). In addition, the proportion of female students in the treatment group who participated in muscle fitness activities for more than three days per week was significantly higher than those in the control group (58% vs 41%, $p = .03$), and their sedentary behavior proportion was also significantly lower than the control group (20% vs 37%, $p = .04$).

In another intervention study, Contento and colleagues (2010) demonstrated success in changing students' behaviors associated with energy balance. They implemented a 24-lesson-long curriculum among 562 middle school students (Age: $M = 12$, ranging from 11 to 13); while the other 574 students with similar demographic characteristics taught by traditional physical education were assigned into the control group. Grounded on the social cognitive theory (Bandura, 1997) and the self-determination theory (Deci & Ryan, 1985), the curriculum incorporated motivational strategies to promote obesity risk-reducing behaviors (i.e., eating healthier and being more physically active). The curriculum was taught by science teachers who received the intensive 3-hour-long training prior to the intervention. It was found that the curriculum intervention significantly reduced energy intake measured as days of consuming sweetened beverages in meals or with snacks ($F = 14.84, p < .00$ or $F = 11.45, p = .001$); size of sweetened beverage in meals or with snacks ($F = 18.91, p < .001, F = 6.78, p = .009$); size of fast food ($F = 9.65, p = .002$), and increased physical activity level

measured as purposefully taking stairs for exercise ($F = 18.51, p < .001$). The findings suggest that sound conceptualizations of energy balance as well as motivation have a positive impact on students' healthful living behaviors (i.e., eating healthier, being more physically active).

In summary, large-scale intervention studies have supported that essential knowledge has positive effect on changing youths' healthful behaviors. Physical education and health professionals should lay emphases on fostering students' conceptual understanding of essential concepts/knowledge in light of the obesity epidemic. Contento et al. (2010) particularly implemented a curriculum intervention to promote students' energy-balance behaviors by manipulating the energy balance equation. The study has recognized the importance of energy balance in obesity prevention and management. More research and practice should devote to exploring students' understanding of energy-balance knowledge and its impact on energy-balanced living. In addition, both intervention studies (Contento et al., 2010; Dale et al., 1998) indicate that conceptual understanding can be the antecedent or an important (not necessarily a causal) condition for behavioral changes. Through focusing on student cognitive understandings and/or meta-cognitive strategies, both studies have successfully strengthened students' healthful behaviors (i.e., physical activity and appropriate nutrition behaviors). Thus, it is reasonable to claim that energy-balance knowledge has large potential to increase students' physical activity (both in-class and after-school).

The Cold and Warm Conceptual Change

Pintrich et al. (1993) classified the majority of conceptual change research in literature as “cold conceptual change”. They argued that hardly do students activate or transfer knowledge automatically; instead, motivational constructs such as goals, values, self-efficacy, and control beliefs are potential mediators of conceptual change and should be studied thoroughly (Pintrich et al., 1993). Pintrich et al. (1993) postulated that a “warm” conceptual change must involve high motivation in the learner that fuels the process of cognitive and behavioral engagement leading to effective construction of scientific mental models.

Similarly, Dole and Sinatra (1998) pointed out the importance of integrating motivation and conceptual change in schooling. It was theorized that to entice conceptual change four essential factors including motivation should be taken into account: one’s existing knowledge, characteristics of the new information, motivation, and engagement level of the meta-cognition in processing the new information (Dole & Sinatra, 1998). These four factors can help students activate their meta-cognition that enables them to actively engage in changing the currently held mental models toward scientific models. The strong motivation, when nurtured, can not only instigate learners to approach and interact with the new conceptions, but also increase the meta-cognitive engagement underlying conceptual change.

In addressing a warm conceptual change, educational psychologists have theorized the relationship between motivation and conceptual change by collating relevant findings from various motivational studies in education. These insights have

provided directions for future research on the role of motivation in facilitating conceptual change. It provoked me to identify the extent to which student motivation would influence the effort in constructing essential knowledge (e.g., energy-balance knowledge).

Motivation

Definition of Motivation

Motivation refers to “the process whereby goal-directed activity is instigated and sustained” (Pintrich & Schunk, 2002, p. 5). Motivation consists of two components: energy and direction. It is argued that learners could become energized by multiple sources (Pintrich, 2003). These sources of energy can originate either from the learner him/herself (i.e., dispositional motivation) or from the context (i.e., situational motivation) in which the learner resides. The other component of motivation is direction, or what a learner is motivated for. Alexander (2006) argues that the implication of motivation lies in its functional meaning to educational outcomes (e.g., achievement). Educators should not only energize students but more importantly should channel this energy toward meaningful learning goals or achievements. There are five major contemporary motivation theories that have informed the ways to instigate and sustain learners in goal-oriented activities: the achievement goal theory (Dweck & Leggett, 1988; Nicholls, 1984), the expectancy-value theory (Eccles, 1983), the interest theory (Hidi, 1990), the self-determination theory (Deci & Ryan, 1985), and the self-efficacy theory (Bandura, 1997). Among these five major theories, the expectancy-value theory has conceptualized strong motivators (i.e., expectancy beliefs for success and subjective task values) in the domain of physical education. It was the theoretical lens of this dissertation research to examining

student motivation. In the following paragraphs, I first briefly described the four motivation theories and then articulated the expectancy-value theory in detail.

Major Motivation Theories

The achievement goal theory. Achievement goals are conceptualized as purposes of achievement behaviors that guide the way the learner approaches, engages in, and responds to achievement tasks (Dweck & Leggett, 1988). Researchers (e.g., Nicholls, 1984) have framed learner goals into ego/performance orientation and a task/mastery orientation. Learners with the task/mastery goal orientation tend to emphasize self-referenced improvement and attribute failures to insufficient effort. In contrast, learners with the ego/performance goal tend to emphasize norm-referenced information and attribute failure to lack of ability. Currently, the dichotomous goal constructs have been extended the 2×2 framework by distinguishing approach goal orientations (i.e., mastery approach, performance approach) from avoidance goal orientations (i.e., mastery approach, performance approach). The mastery-avoidance goal refers to the profile that a learner avoids not being able to improve, whereas the performance-avoidance goal refers to the avoidance of displaying normative incompetence (Elliott & Harackiewicz, 1996). In addition, researchers have studied the effect of goal structured environment on goal orientations and motivational outcomes. Evidence shows that goal structured environments can strengthen the goal orientations that are corresponding to the structured environment (Todorovich & Curtner-Smith, 2003). It was found that the mastery-involving climate in physical education promotes satisfaction of learning experiences and

enhances perceived learning outcomes and performance (Mitchell, 1996; Papaioannou, 1998; Xiang & Lee, 1998).

The interest theory. Interest, as a motivator, is a psychological state characterized by a high level of attention, intensive effort, and prolonged engagement in an activity accompanied by feelings of pleasure and a sense of achievement (Hidi, 2000). In research, interest is conceptualized as individual interest and situational interest (Hidi, 1990). Individual interest refers to an individual's psychological disposition that guides personal preferences for activities/action. Situational interest refers to the appealing effect of an activity or object that triggers attention and engagement from an individual at the moment of person–activity interaction. In physical education, Chen and colleagues revealed the multi-dimensional nature of situational interest (Chen, Darst, & Pangrazi, 1999) and found that cognitive demand of a physical activity determines the level of situational interest (Chen & Darst, 2001). Studies examining the relationship between interest and learning indicate that individual interest is correlated with knowledge and skill gain, whereas situational interest is correlated with student physical activity levels in physical education classes (Chen & Darst, 2002; Shen, Chen, Scrabis, & Tolley, 2003).

The self-determination theory. The self-determination theory is based on the notion that individuals need to be motivated both intrinsically and extrinsically (Deci & Ryan, 1985). Intrinsic motivation refers to people's drive to undertake an activity for its inherent interestingness or enjoyment, while extrinsic motivation is the drive to engage in an activity in order to be rewarded. The theory further postulates that motivation is a process through which particular psychological needs for competence, autonomy, and

relatedness are fulfilled (Deci & Ryan, 1985). Extrinsic motivation consists of four self-regulation processes. In external regulation, motivation solely relies on the possibility to attain a reward (e.g., recognition from the teacher) or to avoid a punishment (e.g., avoid overweight/obesity). In introjected regulation, motivation is characterized by a strong sense of self-worth or guilt (e.g., a feeling of pride or not letting someone else down). In identified regulation, motivation is based on a sense of identity associated with the desired behavior (e.g., students as NBA players). In integrated regulation, motivation is based on the individual's holistic understanding of the behavior's significance to self, self-worth of a task, and an identified sense of self with the activity (e.g., "It is important to me"). Research in physical education has illustrated the tenability of the self-determination theory (e.g., Ntoumanis, 2001; 2005; Sun & Chen, 2010). The more self-determined motivation (i.e., intrinsic motivation, integrated regulation, identified regulation) tends to contribute to positive outcomes (e.g., concentration, effort, positive affect) than the less determined motivation (see review in Bryan & Solmon, 2007).

The self-efficacy theory. Self-efficacy refers to "judgments of the likelihood that one can organize and execute given courses of action required to deal with prospective situation" (Bandura, 1980, p. 263). Self-efficacy motivation is a function of efficacious information received by the individual. Efficacious information comes from several sources (Bandura, 1997). Previous performance is an important factor on which individuals rely when approaching a task, which affects efficacy expectation and performance. Vicarious experience, namely, watching others perform a task, is another source that can enhance the observer's motivation for undertaking the same or similar

task. Verbal persuasion from significant others (e.g., teacher) may bring encouragement to an individual to work toward success. Physiological state, as another efficacious information source, may also mediate efficacy expectations of an individual and the physical effort put into a task (Chase, 1998).

The Expectancy-Value Theory

Figure 2 illustrates the expectancy-value model developed by Eccle and colleagues (1983). It was postulated that the influence of reality on achievement outcomes are mediated through attributional patterns of failure and success, perception of one's own needs, values, expectations, and the perceptions of a task. These factors influence the expectancies and values related to the task. The expectancies and values then impact achievement-related behaviors, such as choice of tasks, persistence on a task, and performance of the task. Eccles and colleagues have tested and elaborated the expectancy-value model of achievement (Eccles et al., 1983, 1984). As depicted in Figure 2, student achievement-related choices and performances are directly influenced by expectancy beliefs and subjective task values. Expectancies and values, the two constructs, are impacted by personal factors such as individual goal, self-schema, affective reactions and memories. These personal factors, in turn, are presumed to be determined by cultural milieu, individuals' stable genetic traits, and previous experiences.

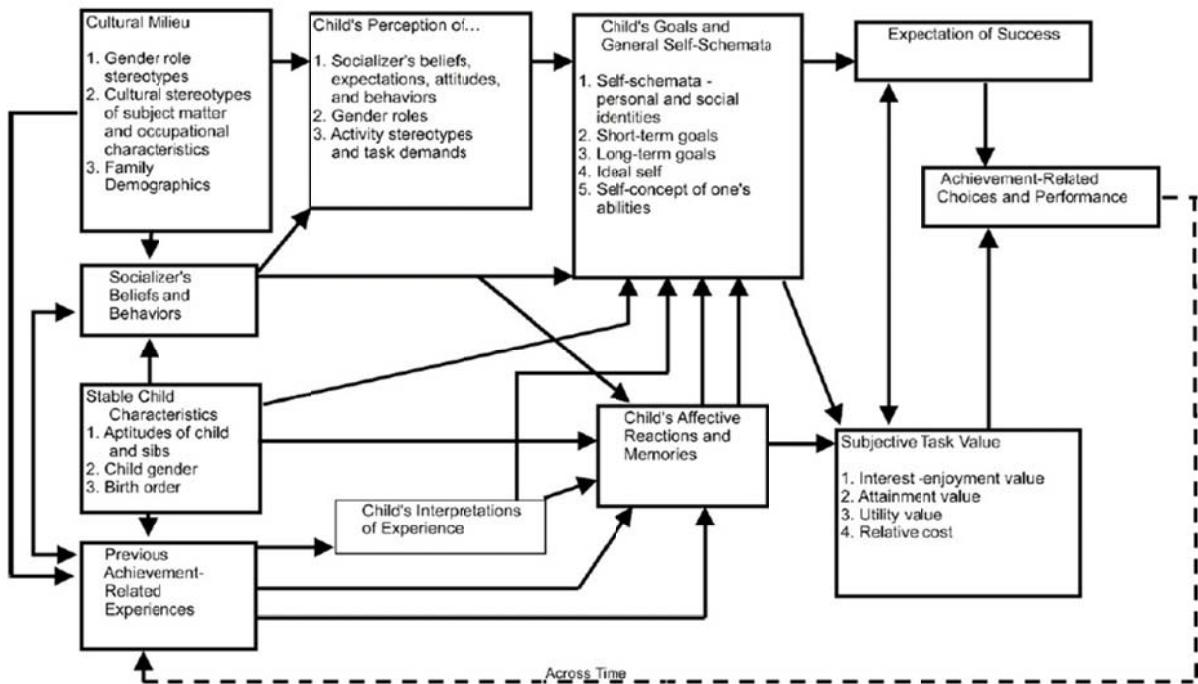


Figure 2. The Expectancy-Value Model (Eccles et al., 1983)

Constructs of expectancy beliefs and values. Eccles and Wigfield (1995)

empirically tested the dimensionality or and relations between adolescents' expectancy beliefs and subjective values in mathematics education. An exploratory factor analysis was initially conducted among 742 predominantly white, middle class students in Grades five through 12; and then a confirmatory factor analysis was conducted one year later among 575 adolescents in Grades six through 12. It was found that the constructs of expectancy/ability beliefs, task value perceptions and task difficulty perceptions were clearly distinguishable. Similarly, the above constructs/dimensions of the expectancy-value model were tested in physical education at elementary (Xiang et al., 2003) and secondary school (Zhu et al., 2009) levels. Expectancy beliefs are learners' judgment on how well they will perform in a future task; while subjective values refer to the perceived

worth that a task may provide for current and future life. Three task values and one cost components have been identified across academic areas and physical education. Specifically, attainment value alludes to the perceived importance of doing well on a given task. For example, exercising may be perceived by students has important which reflects the attainment value. Intrinsic value refers to the extent to which a task provides enjoyable experiences. For example, the intrinsic value is recognized by students when they enjoy playing a game. Utility value is the perceived usefulness of a task. For example, the utility value of energy-balanced behaviors can be captured if students are aware of their implications for weight management and control. Cost refers to the expense or negative consequence of engaging in a task (Eccles & Wigfield, 1995). For example, research has identified physical discomfort associated with physical activity, boring tasks or curriculum, incompetent teachers and perceived incompetence as perceived costs (Chen & Liu, 2009; Xiang et al., 2006).

Motivation for miscellaneous outcomes. A small line of research in physical education has addressed how expectancy-value motivation impacts behavioral indicators such as choice, effort, and performance among students of different school levels. At the elementary school level (i.e., fourth grade), Xiang and colleagues (Xiang et al., 2004) implemented a running program and assessed the relationships among motivation constructs, intention for future participation in running and 1-mile run performance. The adapted *Expectancy-Value Questionnaire* (Xiang et al., 2003) to elementary school physical education was used to measure students' expectancy beliefs and subjective task values. Fourth grade students ($N = 119$) provided data on measures of expectancy beliefs,

subjective task values, achievement goals, intention for future participation, and 1-mile run performance. Multiple regression analyses revealed that intrinsic value ($\beta = .49, t = 5.78, p < .01$) and attainment value ($\beta = .30, t = 3.48, p < .01$) positively predicted students' intention for future participation in running, and that expectancy beliefs positively predicted fourth grade students' performance on the 1-mile run ($\beta = .32, t = 3.41, p < .01$).

At the middle school level, with a similar approach, Gao (2008) explored the interrelations among expectancy-value motivation, engagement, satisfaction, and cardiovascular fitness performance. Participants from sixth, seventh, and eighth grades ($N = 307$) completed self-report measures on the measures of motivation, perceived engagement and satisfaction, and participated in the *Progressive Aerobic Cardiovascular Endurance Run* (Cooper Institute for Aerobic Research, 1999) test. Multiple regression analysis yielded evidence that expectancy beliefs alone significantly contributed to performance on the cardiovascular fitness test ($\beta = .32, t = 5.88, p < .001$); while expectancy beliefs ($\beta = .30, t = 2.38, p < .05$; $\beta = .24, t = 3.3, p < .05$), attainment value ($\beta = .31, t = 3.68, p < .001$; $\beta = .12, t = 2.42, p < .05$) and intrinsic value ($\beta = .24, t = 2.16, p < .05$; $\beta = .55, t = 9.32, p < .01$) contributed to engagement and satisfaction respectively in physical education.

In summary, the above studies have empirically explored the relationships between expectancy-value motivation and miscellaneous motivational outcomes. It is acknowledged that the expectancy beliefs and task values are meaningful motivators in physical education. To compare the effects of the constructs, expectancy beliefs seem to

be a strong motivator for performance-related variables (e.g., 1-mile run, *Progressive Aerobic Cardiovascular Endurance Run*). Instructional and motivational efforts should be committed to strengthening the expectancy beliefs when students are expected to produce high performance or achievement. In contrast, subjective task values are motivators that are more related to attitude (e.g., intention), affect (e.g., satisfaction), or formative variables (e.g., choice, effort, engagement). Of all three values, attainment value and intrinsic/interest value seem to be stronger motivators. These findings imply that teachers should help students recognize the attainment, interest, and utility values of the content/tasks. Nevertheless, these studies are limited in their scope in studying the relationship between expectancy-value motivation and outcomes. For example, meaningful outcome variables such as mastery of essential knowledge (e.g., fitness knowledge, energy balance), psychomotor skills (i.e., motor or sport skills), and physical activity were not measured in most of the studies.

Motivation for knowledge, skills, and physical activity. A handful of empirical evidence informed the connection between expectancy-value motivation and knowledge and psychomotor skills. At the elementary school level, Chen and Chen (2010) explored the relationships among expectancy-value motivation, students' learning of health-related fitness knowledge, and in-class physical activity. The purpose of this study was to investigate the effect of expectancy beliefs and subjective task values on knowledge construction in classes with different levels of physical activity intensities. Data for expectancy-value motivation, health-related fitness knowledge, and in-class physical activity intensity were collected among 753 elementary students from 12 schools (3rd

Grade: $n = 243$; 4th Grade: $n = 243$; 5th Grade: $n = 257$). Due to the nested data structure, the hierarchical linear modeling was used for data analysis. Specifically, the variables of expectancy-value motivation and health-related fitness knowledge were analyzed at the student level and physical activity was analyzed at the class level. It was found that attainment value contributed to knowledge learning ($t = 3.07, p < .01$) under the mediation ($t = -3.10, p < .01$) of in-class physical activity. In addition, in-class physical activity has contributed to the performance of learning fitness knowledge ($t = 3.18, p < .01$). The findings imply that a physical education context with moderate level of physical activity is desirable to facilitate students' performance in learning knowledge and connect the expectancy-value motivation with this learning.

At the middle school level, Zhu and Chen (2010) investigated the influence of expectancy-value motivation on student achievements in constructing health-related fitness knowledge and psychomotor skills. A total of 854 sixth, seventh, and eighth grade students from 12 middle schools provided data on expectancy-value motivation, fitness knowledge and measures of basketball and badminton skills. The expectancy-value motivation was measured by the adapted Expectancy-Value Questionnaire to middle school physical education. The basketball dribbling and badminton overhand striking were assessed during the pre- and post-tests by two validated standardized skill tests (AAHPERD, 1984; Lockhart & McPherson, 1949). Multiple regression analysis found that expectancy-value motivation did not significantly predict knowledge achievement and skill gain, although students have improved their fitness knowledge (Cohen's $d = .58, p < .05$) and badminton skills (Cohen's $d = 1.40, p < .05$) with large effect sizes.

In a dissertation research, Zhu (2009) further examined the influence of expectancy-value motivation on psychomotor skills and after-school physical activity participations. Data were collected from the same 854 students who participated in Zhu and Chen's study (2010). Structural equation modeling analysis illustrated that expectancy beliefs for success significantly predicted students' psychomotor achievement (path coefficient $\beta = .38, p < .05$), which in turn predicted after-school physical activity participation (path coefficient $\beta = .14, p < .05$).

In summary, the above studies have recognized expectancy beliefs and subjective task values as essential motivators for meaningful outcome measures in physical education. Specifically, fitness conceptual knowledge, psychomotor skills, and in-class, after-school physical activity were emphasized as the outcome variables of expectancy-value motivation. This line of research has generated several insights. First, the motivational effects of expectancy-value constructs seem to be distinct across school levels. That is, the attainment value was found predictive to the performance in learning fitness conceptual knowledge at the elementary school level (Chen & Chen, 2010); whereas no expectancy-value motivation constructs have contributed to this knowledge at the middle school level (Zhu & Chen, 2010). Additional empirical evidence is needed to further explore the impact of the expectancy-value constructs on learning outcomes. Second, the expectancy beliefs for success were found motivational for psychomotor skill improvement (Zhu, 2009), 1-mile run performance (Xiang et al., 2004) and cardiovascular fitness test performance (Gao, 2008). These findings suggest that expectancy belief for success is an important motivator for performance- and

achievement-related outcomes. Third, in-class and after-school physical activity have been incorporated in previous studies that studied expectancy-value motivation and outcomes (Chen & Chen, 2010; Zhu, 2009). However, it remains unclear how conceptual understanding of essential knowledge (e.g., fitness knowledge, energy balance) would influence in-class and after-school physical activity.

Effect of cost. The construct of cost has received little research attention in physical education in comparison with expectancy beliefs and task values. Chen and Liu (2009) explored the types of perceived cost in physical education and the extent to which these costs might have affected motivation. The adapted Expectancy-Value Questionnaire was used to measure the expectancy-value motivation of college students ($N = 368$) in four Chinese universities. Students' responses to the cost question items were open-coded and quantified for analysis. The study found that Chinese college students perceived several costs in their physical education program: disappointment at the physical education curriculum (45%), learner-unfriendly learning context (27%), irresponsible teachers and decontextualized assessments (12%). In addition, despite of these perceptions of costs, 90% of the students who disliked physical education stated their intention to take physical education in the future; students who reported the curriculum as a cost did not significantly differ from those who did not report it as a cost in all three subjective task values except the intrinsic value ($F = 8.46, p = .004, \eta^2 = .24$). This study illustrates that cost perceived by students indeed has detrimental effect on the perceived intrinsic value. But the detrimental effect may be overridden by other subjective task values. No previous research evidence has informed the potential effects of cost on

learning variables and physical activity participation. Future research should focus on this literature gap.

The Present Dissertation Research

Research literature relevant to learning theories, conceptual change, behavioral change, and motivation has been extensively reviewed in this chapter. First, the three learning theories (i.e., the behaviorism, information-processing, and constructivism theories) have informed the formulation of my lens to study student learning in physical education. Learning was theorized as conceptual and behavioral changes throughout the present dissertation. Second, several motivation theories were briefly reviewed; while the expectancy-value theory, as the motivation lens for the study, was reviewed in relation to its motivational function to outcome measures with more details. Reviewing the existing research literature has identified theoretical gaps to be filled in the future studies, and has provided provocative insights for the present dissertation research. In this dissertation research, I aimed to address the following research questions: (a) To what extent did expectancy-value constructs affect energy-balance knowledge, in-class and after-school physical activity? (b) To what extent did ninth graders construct their mental models about energy-balance knowledge? and (c) To what extent did their mental models developed in health education affect physical activity behavior in physical education and after-school hours?

CHAPTER III

RESEARCH METHODS

In this dissertation, I examined the extent to which expectancy-value motivation contributed to energy-balance knowledge and physical activity, the extent to which ninth graders correctly constructed energy-balance knowledge, and the extent to which energy-balance knowledge influenced physical activity participation. The existing literature recognized the necessity to test the relationships among above variables with a confirmatory perspective. The methodological task for this research, specifically, was to test the *a priori* model depicted in Figure 3. The model consists of both observed and latent variables. The most appropriate analytical design to test the tenability of the model is the structural equation modeling approach (Hancock, 2006). In this chapter, I described in detail the research setting and participants, variables and measures, procedures of data collection, reduction and analysis, threats to validity and reliability and strategies used to address these threats.

Research Setting and Participants

Research Design

Correlational design belongs to the family of non-experimental designs. The salient characteristics of this design are the lack of manipulating independent variables and the lack of randomized assignment of participants to various conditions. There are two primary types of correlational designs. One is descriptive or predictive; the other

explanatory or interpretative. The distinction between the two, according to Pedhazur and Schmelkin (1991), is that the explanatory/interpretative design is based on well-developed theoretical articulation of relationship among variables. Its goal is not to uncover eclectic, non-directional relations among variables. Rather it is to examine and test well-formulated theoretical models that explain the theorized relationship with directional (e.g., cause-effect) implications. The goal of this dissertation study was to seek explanatory relationship among energy-balance knowledge, physical activity behavior, and motivation in high school students. Thus, the study was designed with the following features.

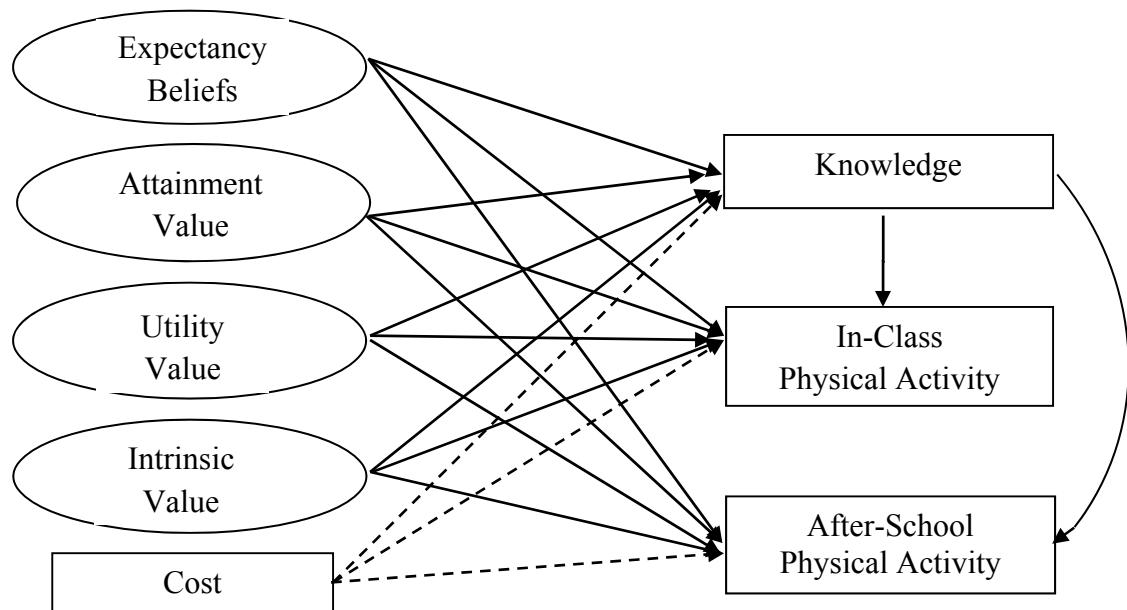


Figure 3. The Hypothesized Model. Ovals enclose latent measures. Rectangles enclose observed measures. Solid lines signify positive paths. Dash lines signify negative paths.

The goal of the design was to test the *a priori* model developed based on in-depth review of both theories and empirical evidence. Formulating the model was the first step of the design. The model in Figure 3 signifies the completion of this step. The design was not intended to infer observed relationship among dependent variables and manipulated or designated independent variables such as instructional conditions, gender, or social-economic status. Therefore, no control conditions were imposed. Inferences about the relations among the variables were made through testing the tenability of the *a priori* model and its variations.

No randomized participant assignments were used in sampling procedures. Sampling decisions were based on the power analysis to satisfy statistical assumptions for structural equation modeling, which maximized the likelihood of generating valid and reliable explanatory/interpretive parameters in the outcome model(s). Details of sampling were presented in the sections below.

Research Site

The county and schools. The Guilford County School District (GCS) of North Carolina in which the university resides was chosen as the site to conduct this research. It was ranked as the 49th largest public school district by population in the U.S. The students of the GCS were ethnically diverse from background of low to middle socio-economic status. There were 15 traditional high schools in GCS with a median enrollment of 1,287 students (ranging from 870 to 1909). Two high schools with homogeneous characteristics on race/ethnicity, percent of free/reduced meal eligibility, pupil/teacher ratio and average school size were selected to be the research settings.

Table 1 illustrates the demographic data describing about the GCS and the two selected high schools on these key characteristics.

Table 1. Information about the GCS and the Two Targeted High Schools

	<i>GCS</i>	<i>School A</i>	<i>School B</i>
Race/Ethnicity			
<i>Whites %</i>	39%	39%	43%
<i>Other %</i>	61%	61%	57%
Free/Reduced Meal	53%	42%	39%
Pupil/Teacher Ratio	14.9:1	16.3:1	15.2:1
Average School Size	678	1842	1497

Note. Data obtained from the following sources: a. Education First NC School Report Cards, www.ncreportcards.org; b. Public Schools of North Carolina, www.ncpublicschools.org.

Reasons for choosing GCS. In addition to its close proximity to the University, there were two reasons that I chose GCS as the research site. First, I have visited many elementary, middle, and high schools of GCS to conduct research and supervise student teachers in the past three years. These experiences afforded me opportunities to interact with teachers and students and to know physical education programs at all three levels. The interactions helped me develop sound professional relationship with teachers who expressed support for conducting research in their programs. Second, the study was consistent with the goal of GSC wellness plan (e.g., incorporating physical activity as part of holistic education, the “eat smart” campaign) that was developed in 2006 and fully

implemented thus far. The focus of this study on energy balance and physical activity behavior in relation to student motivation would address GCS's concerns about students' imbalance of nutrition and physical activity. The findings might not only contribute to theoretical understanding of GCS healthful living programs, but also provide tangible evidence for future program planning.

Reasons for choosing the two schools. Because the goal of the study was to identify high school students' concepts of energy balanced living, the primary criterion for school selection was that the concepts should have been taught to students. The two schools met this criterion. Second, as a field-based research, the success of the study relied in part on the support of school personnel, particularly that of teachers. School A was chosen because I had developed a sound professional relationship with the teachers through a previous research experience. School B was chosen because it was referred to me by a UNCG professor who knew the teachers would support my research due to their own professional interest in the topic. The final selection decision also relied on my pilot works in the schools. In these pilot works I observed classes, interacted with the teachers, examined the health education content, conducted informal interviews with the teachers, and piloted concept mapping with students. The decision was made after the pilot work confirmed that the above selection criteria were met.

The curriculum. Required by the state and the school district, the two high schools implemented the healthful living curriculum, a combined curriculum of physical education and health education. The students were exposed to half a semester of physical education classes and half a semester of health education classes. The healthful living

classes, either with focus on physical education or on health education, were taught daily Monday to Friday. The lesson duration varied between the two schools. The School A had 90 minutes of lesson duration; while School B had 50 minutes. The traditional multi-activity curriculum was adopted and implemented in both schools (Metzler, 2011). The students had the opportunity to participate in multiple activities or sports with each activity lasting for about two weeks. At the time of data collection, the students participated in track and field events, ultimate Frisbee, football, and pickleball.

The teachers. All four teachers were certified physical educators with teaching endorsement in health education. The four teachers held bachelor's degree, two of whom had received master's degree in physical education. Their teaching experiences ranged from seven to 28 years. Of the four teachers, three were male and one female. All teachers coached at least one of the following sports at their high school: baseball, cross country, football, soccer, and tennis.

Research Sampling

Target population. The target population of the dissertation research was ninth grade students. Ninth grade students were chosen primarily because they previously experienced physical education, health education, and science education in elementary and middle schools. They might have constructed the energy-balance knowledge to some extent, and some might even have incorporated this knowledge into voluntary behaviors (e.g., exercising). Thus, it was expected that they could articulate the relationship between energy balance and physical activity better than their younger peers in elementary and middle schools. A second reason for choosing ninth grade students was

that ninth grade was the last year of mandatory physical education in North Carolina (NASPE & AHA, 2010). Targeting students of this grade level on their motivation, energy-balance knowledge and physical activity is important as they are about to advance to a stage where energy-balanced living behaviors become voluntary.

Sampling size determination. To determine the student sample size while achieving adequate statistical power, the *a priori* power analysis was conducted. The root mean square error of approximation (RMSEA) is an index commonly utilized for testing model fit in structural equation modeling (Kline, 2005). Because of its importance in determining the tenability of a formulated model, it is often used to determine the minimum sample size for the structural equation modeling procedure. Models with RMSEA values smaller than .05 are considered having satisfactory fit. Hancock (2006) created a statistical power table for determining minimum sample size needed for structural equation modeling based on predetermined RMSEA ranges (i.e., .00, .02, or .04). It is posited that RMSEA value of .02 seems to be a reasonable level; while .00 is unrealistically optimistic and .04 impractically conservative (Hancock, 2006). In practice, to achieve at least 80% of statistical power at a .02 RMSEA level, it is further necessary to compute degrees of freedom for the model by using the following formula:

$$df = \frac{p * (p + 1)}{2} - t$$

Where df = degrees of freedom, p = number of observed variables, and t = number of parameters.

The hypothesized model in Figure 3 had 27 model parameters and 16 observed variables, which yielded 109 degrees of freedom. Using the statistical power table in Hancock (2006), I was able to determine that the sample size needed at .02 RMSEA and 110 degrees of freedom was 202. The sample size of 202 should provide 80% of statistical power. This sample size was considered large based on Kline's (2005) sample size classification for structural equation modeling procedures (small, $N < 100$; medium, N between 100 and 200; large, $N > 200$). Combining the above approaches, the sample size of 202 would provide sufficient statistical power for analyzing the proposed model.

Sampling procedures. A sampling procedure similar to cluster sampling was followed to select 202 ninth grade students. Cluster sampling refers to the sampling procedure that selects clusters or aggregates of elements; while all elements from the selected clusters are included as participants (Pedhazur & Schmelkin, 1991). The clusters in this study alluded to classes. The number of classes to be selected was further determined by the number of participants and class size. A total of eight to 12 classes from two high school physical education programs were identified as the clusters. As shown in Table 1, the two high schools had similar characteristics. However, the above sampling procedure differed from cluster sampling in that the classes in this study as clusters were not randomly selected. Ninth grade physical educators who had previously taught energy-balance knowledge were identified first. Then, the intact classes taught by these teachers were invited for participation.

The sample. Following the proposed sampling procedures, 195 students from 12 classes taught by four physical educators in the two high schools contributed data to this dissertation research. Following the IRB protocol, only those whose parents/guardian consented for their participation were included in the study. The sample consisted of 80 boys and 115 girls. Data of student ethnicity were not collected as they were not disclosed by the physical educators in both schools.

Variables and Measures

Expectancy-Value Motivation

The Expectancy-Value Questionnaire (Zhu, Chen, Sun & Ennis, 2009), shown in Figure 4, was used to measure students' expectancy beliefs for success, perceived task values and cost. Expectancy beliefs for success were measured by five items. Each of the three perceived task values was measured by two items. The question items for expectancy beliefs and task values were on the 5-point Likert scale. Cost was measured by three open-ended questions. The first two cost question items measured participants' perception of cost in physical education classes, and the third item measured their perception of cost in overall physical activity settings. The questionnaire demonstrated high construct validity. The latent structural reliability coefficient *Rho* (ρ) exceeded .90 (Zhu et al., 2009).

Energy-Balance Knowledge

Concept-mapping was used to generate data on students' energy-balance knowledge as associated with physical activity and healthful living concepts. Concept-mapping is a graphical tool for organizing and representing knowledge, which includes

1. How good are you in physical education?
 Very good 5 4 3 2 1 Not good
2. If you give 5 to the best student in PE and 1 to the worst, what you give to yourself?
 Best 5 4 3 2 1 Worst
3. Some kids are better in one subject than in another. For example, you might be better in math than in reading. Compared to most of your other school subjects, how are you doing in PE?
 A lot better 5 4 3 2 1 A lot worse
4. How well do you think you are doing in learning in PE?
 Very well 5 4 3 2 1 Very poorly
5. How well are you keeping yourself physically active in PE?
 Very well 5 4 3 2 1 Very poorly
6. How important do you think PE is for you?
 Not very important 1 2 3 4 5 Very important
7. Compare to math, reading, and science, how important is it for you to learn PE content?
 Not very important 1 2 3 4 5 Very important
8. In general, how fun do you think your PE classes are?
 Very boring 1 2 3 4 5 Very fun
9. How much do you like your PE classes?
 Don't like it at all 1 2 3 4 5 Like it very much
10. Some things that you learn in school help you do things better outside of school. We call this being useful. For example, learning about plants at school might help you grow a garden at home. How useful do you think the concepts you learned in PE are?
 Not useful at all 1 2 3 4 5 Very useful
11. Compared to your other school subjects, how useful are the skills learned in PE?
 Not useful at all 1 2 3 4 5 Very useful
12. If there is anything that you don't like in PE, what would that be? Why? (Open-ended)
13. If you had a choice, would you rather not come to PE? Why? (Open-ended)
14. If there is anything that you don't like physical activity, what would that be? Why? (Open-ended)

Figure 4. *The Expectancy-Value Questionnaire*

clustering concepts and linking relationships between concepts (Novak, 2005; Novak & Canas, 2008; Novak & Musonda, 1991). Two textbooks about nutrition and wellness were referred to for concept selection (Corbin, Welk, Corbin & Welk, 2011; Friedman, Stine, & Whalen, 2009). Corbin et al. (2011) is considered an authority textbook for concept-based fitness education for at least two decades. Friedman et al. (2009) was the textbook chosen by the Guilford County Schools as the textbook for health education. Basing concept selection on these two sources maximized content accuracy and context relevance. Energy-balance concepts were selected from the high school health education textbook only (Friedman et al., 2009) and cross-checked with Corbin et al (2011).

A set of criteria was established for concept selection: (a) Concepts must be about energy intake and energy expenditure as related to physical activity, its health benefits, or weight management. (b) Concepts must be important as manifested in the textbook using color highlighted definition boxes or other means (e.g., colored, bolded, italic fond, graphic illustration). (c) Concepts must be verified as having been taught to the participating students in formal instruction prior to the study. Informal verification interviews with all the teachers were conducted during the pilot study. In summary, the concepts shown in Table 2 have met the selection criteria and tapped students understanding of core knowledge of energy balance. In the test, they were instructed to cluster concepts and make propositional links among the concepts in answering a focus question: How does energy balance affect our body weight change? The approach of concept-mapping could provide highly reliable data on knowledge and knowledge structures of testees (McClure, Sonak, & Suen, 1999; Novak & Musonda, 1991).

Table 2. *The List of the Concepts for Concept-Mapping*

Concepts			
Energy Balance	Energy Intake	Energy Expenditure	Food
Beverage	Obesity	Weight increase	Weight Loss
Fat	P.E.	Physical Activity	Metabolism
Carbohydrate	Protein		

Note. Concepts obtained from Chapter 8 of Friedman, Stine, & Whalen. (2009).

In-Class Physical Activity

In-class physical activity was assessed using ActiGraph GT3X accelerometers (ActiGraph, Shalimar, FL). The accelerometer is a small ($1.50 \times 1.46 \times .71$ inches), light (0.95 oz) device housed in a plastic case. It measures and records physical activity counts in three physical axes. The intensity of physical activity (low, moderate, high or very high) was determined according to the cutoff points categorized by Sasaki, John and Freedson (2010) (light: count < 1952; moderate: 1953-5724; high: 5725-9498; very high: > 9498). The device demonstrated high intra-instrument reliability ($r = .86$) and inter-instrument reliability ($r = .86 - .89$) (Melanson & Freedson, 1995).

After-School Physical Activity

Voluntary physical activity during after-school hours was measured using the modified *Three-Day Physical Activity Recall* (Weston, et al., 1997). The instrument, shown in Table 3, has been used to provide a proximate measure of physical activities in the free-living condition in population-based studies (e.g., Pate, Ross, Dowda, Trost, &

Table 3. *Three Day Physical Activity Recall Instrument*

INSTRUCTION: The following table divides each hour from 3:00 p.m. to 10:00 p.m. into four 15-minute boxes. Your task is to think about what you did yesterday during this time and fill in each 15-minute box with the activities listed below. If you did not do any of the activities during a 15-minute period, write "none" in that box. You can use a line to show the same activity you did in more than one 15 minute period. Do not leave any boxes unfilled.

IMPORTANT: Please turn in the completed form to your physical education teacher tomorrow. Otherwise you will have to sit with the UMD data collector to fill out the form during your physical education class.

EXAMPLE:	3:00-3:15 p.m.	3:16-3:30 p.m.	3:31-3:45 p.m.	3:46-4:00 p.m.
	Walking home	Nap	Homework	

TIP: You can do this quickly if you ask your parents (or someone who looked after you yesterday afternoon) to help you.

Print: Name _____		School _____	
Grade: _____		Age: _____ Gender (circle one): <u>Boy</u> / <u>Girl</u> Date: _____ / _____ / _____	
Example Activities: (You should write any activities you did, even they are not in the example)		Eating Reading Baseball Dance Karate Swimming Homework Sleeping Basketball Football Ping pong Tennis Napping TV Bike Golf Running Volleyball On bus/car Badminton Bowling Gymnastics Soccer Walking	
3:00 - 3:15 p.m.	3:16 - 3:30 p.m.	3:31 - 3:45 p.m.	3:46 - 4:00 p.m.
4:00 - 4:15 p.m.	4:16 - 4:30 p.m.	4:31 - 4:45 p.m.	4:46 - 5:00 p.m.
5:00 - 5:15 p.m.	5:16 - 5:30 p.m.	5:31 - 5:45 p.m.	5:46 - 6:00 p.m.
6:00 - 6:15 p.m.	6:16 - 6:30 p.m.	6:31 - 6:45 p.m.	6:46 - 7:00 p.m.
7:00 - 7:15 p.m.	7:16 - 7:30 p.m.	7:31 - 7:45 p.m.	7:46 - 8:00 p.m.
8:00 - 8:15 p.m.	8:16 - 8:30 p.m.	8:31 - 8:45 p.m.	8:46 - 9:00 p.m.
9:00 - 9:15 p.m.	9:16 - 9:30 p.m.	9:31 - 9:45 p.m.	9:46 - 10:00 p.m.

Sirard, 2003; Weston et al., 1997). The instrument provides a grid divided into 15-minute segments or blocks in which students recall and record all activities occurred between 3:00 and 10:00 p.m. It listed 30 common activities grouped into the following categories: sport, fitness, other physical activities, academic/homework, rest, entertainment, and socialization. For each 15-min block, students entered the main activity they participated in. The main activity was defined as one that occupied most of the 15-min period. The instrument demonstrated strong evidence for test-retest reliability ($r = .98$) and concurrent validity ($r = .77$ with accelerometers) in previous research (McMurray et al., 2004; Weston et al., 1997). Further, as the physical activity recall period extended from one day to three days, researchers were able to obtain a more reliable estimate of voluntary physical activity (Trost, 2001).

Procedures

The procedures of conducting this dissertation research consisted of three phases. Table 4 illustrated the general timeline of these procedures. In Phase One, official approvals from GCS and the Institutional Review Board (IRB) at the University were secured. In Phase Two, data collection activities were operated and lasted for five weeks in the two target high schools. In Phase Three, I conducted data analysis and finished writing the dissertation. Specific procedures are described in detail in the following paragraphs.

Phase One: To Obtain Approvals

GCS approval. Approvals from GCS and IRB were secured in order to gain legal access to the research site. The application for conducting this research was initially

submitted to the Research Review Committee of GCS for review on February 11. Upon review, a notification of minor revision was received within a week. The revised proposal with questions and comments carefully addressed was submitted and then approved on February 24. The official approval letter from GCS is attached in Appendix A. While waiting for the decision from GCS, I maintained contact with physical education teachers at the two target high schools. The teachers were informed of research topic and procedures and expressed support for conducting the research in their schools.

Table 4. *Tentative Timeline for the Dissertation Progress*

<i>Phase</i>	<i>Time</i>	<i>Activity</i>
1	Feb 18- Apr 1	IRB and GCS Approvals, piloting and sampling
2	Apr 4 – Apr 29	Data Collection
	Apr 4 – Apr 8	Obtaining student rosters, consent and assent forms
	Apr 11 – Apr 15	Administering motivation questionnaires and concept-mapping
	Apr 18 – Apr 22	Collecting physical activity data
	Apr 25 –Apr 29	Collecting physical activity data
	May 2 – May 6	Data collection make-up
3	Apr 30 – July 11	Reducing and Analyzing data & writing dissertation

IRB approval. The IRB application was prepared and submitted to the University for expedited review two days after the dissertation proposal was approved by my Advisory/Dissertation Committee on March 2. To abide by federal regulations, the application was revised for three rounds. The pinpointed comments for revision pertained

to human subject privacy and confidentiality protection. The application was approved on March 15. The official approved letter, consent and assent forms are presented in Appendix B.

Letters of support. Letters of support from the two target high schools were obtained from the school principals and physical educators while waiting for the IRB approval. Physical educators were approached with a written research summary which described the purpose and procedures of the research. Procedures were further elaborated in the subsequent conversations. With consent, teachers recommended their classes as potential clusters of participants, and helped me determine the tentative timelines for each data collection procedure. The letters of support were signed by both the teachers and their principals and then returned to me.

Instrument piloting. A preliminary protocol of concept-mapping was created and piloted in one regular class of ninth grade students ($N = 28$) in the School One. Piloting was necessary in determining the extent to which the selected concepts had appropriate level of difficulty and relevancy for the targeted student sample and represented the energy-balance knowledge. The piloting procedure consisted of a practice session on concepts about dogs followed by a session on concepts of energy-balanced living. During the tests, students responded interactively in the practice session and appropriately clustered and linked the dog concepts. They then transferred and applied the mapping skill learned in the practice session to cluster and connect the concepts related to energy-balance knowledge. The pilot test demonstrated that a practice concept-mapping session was necessary for students to direct their attention to the mapping task and to learn the

mapping skills. It also revealed the need for students to revise their concept maps after they were completed. The students needed the time to review and ponder the concept maps.

Use of expert panel. Also in the pilot procedures, the protocol to complete the concept mapping was examined and evaluated by a panel of four physical education pedagogy researchers. The panelists were researchers who, in previous research, had demonstrated expertise in collecting similar data and validating data-evaluation rubrics. All had a record of presenting their research on concept learning in physical education at AAHPERD and/or AERA conferences. The panel revised and finalized the protocol after two hours of deliberation. The protocol evaluation resulted in adding or deleting concepts, revising difficult directions, and standardizing the procedures.

Phase Two: Data Collection

Obtaining consent and assent forms. In Week One of data collection, I began with obtaining parental permission and participant assent. Students and their parents/guardians were informed, via assent and consent form respectively, of the research purpose, procedures, and potential benefits and risks for participation. I also met the students and presented detailed information about the study. Consent forms were taken home by the students for parents/guardians. Participation in the research was voluntary. Students were informed of their rights to decline or withdraw from participation. Those without parental/guardian permissions were identified as non-participants from whom no data were collected. Questions from students were answered immediately in the meeting; while questions from parents/guardians were addressed

through email and telephone. An identification number was assigned to each individual participant. This number rather than student name was used throughout the research to maintain participants' confidentiality.

In Week Two, I administered the Expectancy-Value Questionnaire and concept-mapping with all student participants. Participants were first instructed to complete the Expectancy-Value Questionnaire and then the task of concept-mapping. This sequence was purposefully arranged so that students would respond to the motivation measure without being influenced by concept-mapping, because concept-mapping process might provoke students to reflect upon the values of energy balance and benefits of physical activity. The reflection might lead to a positive reaction to physical activity motivation which would skew students' responses to the questionnaire.

Administering the Expectancy-Value Questionnaire. The questionnaire was administered at the beginning of a physical education class. Students were informed of the purpose of the questionnaire and instructed to respond honestly and independently. They were also informed that there was no right or wrong answers to the questions, and their responses would remain confidential with no influence on their grades. The students were asked to sit quietly in a personal space on the gymnasium floor, which was about five feet apart from each other. I distributed pencils and questionnaire to each participant. I then read each item and choices of response firmly and slowly. Fifteen seconds of intervals were provided for each Likert-scale item. Three minutes were provided for each open-ended cost item. Students were informed to ask questions that I subsequently addressed.

Conducting concept-mapping. As a data collection tool, the validity and reliability of concept mapping data rely on respondents' understanding of the procedure and their cooperation in data collection (Novak & Canas, 2008). In testing, I conducted a simulated practice of concept-mapping for the students to become familiar with the technique. In the practice session, students were provided with and asked to comprehend concepts about dog: *Whine, growl, bark, dog sounds, dogs, body parts, tail, paws, ears, fur, run away, scratch, breeds, Beagle, dogs behaviors, Collie, Scottie*. The practice session was conducted procedurally in which students voiced interactively their inputs and I reacted by writing them on the whiteboard. Specifically, students and I collectively conducted the following stepwise procedures: (a) clustering concepts by spreading them out in an open space; (b) drawing lines or arrows for every identified relation; (c) adding written explanations using relational phrases for each linked relation. Once the above procedures were complete, students were prompted to revise their concept maps. The practice session lasted for approximately 10 minutes.

Figure 5 shows a dog concept-map example that was drawn by majority of the students. Shown on the concept map, all concepts were appropriately clustered under four leading concepts: *Dogs, Dog Sounds, Body Parts* and *Dog Breeds*. Written descriptions such as “*make*”, “*a type of*”, “*include*” were marked clearly to link the relations among every two concepts. The concept-map example indicated that most students have learned the concept-mapping skills through this practice session.

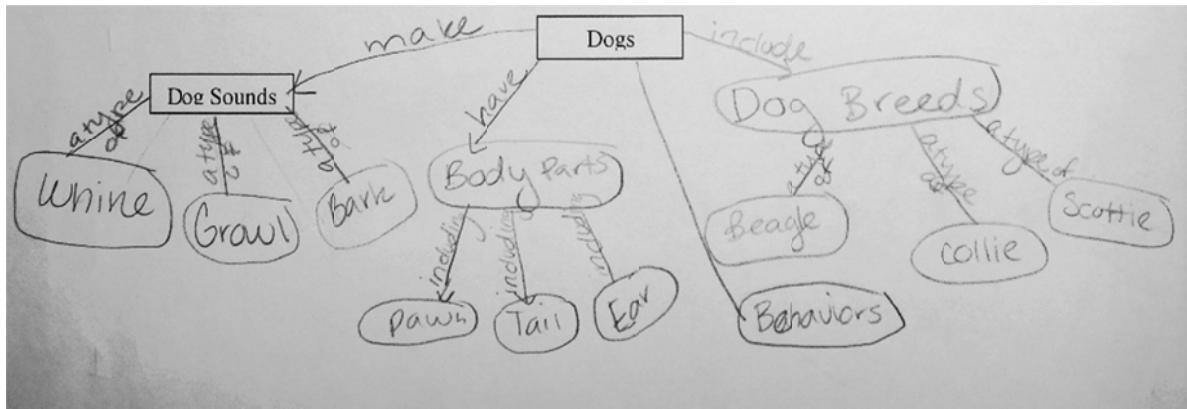


Figure 5. A Dog Concept-Map Example

Following the practice session, the procedures were utilized to conduct concept-mapping for energy-balance concepts. Appendix C illustrates the data collection worksheet for both practice and actual concept-mapping. The worksheet contained 16 concepts extracted from the health education textbook (Friedman, et al., 2009) (Table 2) due to their relevancy to energy-intake and energy-expenditure behaviors and body weight management. The data collection worksheet and pencil were distributed to all participants. During concept mapping, the students were asked to respond to a focus question while doing concept-mapping for energy-balance concepts: How does energy balance affect our body weight change? The stepwise procedures of doing concept-mapping learned during the practice session were followed. I checked students' work periodically to ensure that they had understood the techniques and procedures. Questions or confusions from the students were addressed immediately. The task lasted for approximately 15 minutes.

Collecting in-class physical activity data. In Week Three and Four, I collected students' in-class physical activity data using ActiGraph GT3X accelerometers. Prior to

the data collection, students were taught how to put on the device properly and had the opportunity to wear it for one class session at least one day before the data collection began. This procedure was useful for students to get used to the equipment in moving around. It allowed me to minimize the effect of reactivity (Heppner, Wampold & Kivlighan, 2008) and improved the reliability of the accelerometer data. The night before data collection, accelerometers were fully re-charged and programmed for the scheduled class periods. The devices were distributed to participants at the beginning of the lesson when the teacher was taking attendance. Students wore the devices throughout the entire class and then returned them to me when the lesson was over. In-class physical activity was assessed in two separate lessons for each class. Data were uploaded to a data computer at end of each data collection day.

Collecting after-school physical activity data. Students were instructed to recall their physical activity on the *Three-Day Physical Activity Recall* survey. In order to reflect daily after-school physical activity type and level, two week days and one weekend day were selected for the students to recall their activity. Students were instructed during school time to pay attention to types and duration of activities that they would participate in during their after-school hours (3:00-10:00pm). On next day, I met them again in class and distributed pencils and the survey on which they were to document their activities occurred during the after-school hours the day before. To assist recall, I reviewed the structure of the instrument and the procedures to fill into each cell with their primary activity. Students were instructed to recall and record the activities as accurate as possible. I remained in the setting to address any questions from the students.

The same procedures were repeated in two other days until all three days of recalls completed.

Phase Three: Data Reduction

Data from survey (i.e., Expectancy-Value Questionnaire and Three-Day Physical Activity Recall), concept-mapping, and physical activity were organized and entered into a SPSS18.0 data base by students' identification number, gender, school, teacher name, and class. Data sheets were examined carefully to sort out incomplete or missing data. The missing data were mainly on the variables of expectancy-value motivation and energy-balance knowledge. Additional school visits were arranged and fulfilled to collect these missing data. To keep consistent with the regular data collection protocol, motivation data were collected first, and then followed by knowledge data. Since missing data on physical activity were few to none, they were not collected. Data reduction and analysis procedures are elaborated below.

Expectancy-value motivation variables. Responses to the expectancy beliefs, attainment value, intrinsic value, and utility value were aggregated by dimensions. For example, the five items for expectancy beliefs were aggregated to represent the dimension of expectancy beliefs. Students' responses to the three open-ended cost items were coded into numeric fashion in reference to a set of scoring rubrics to represent cost perceptions in physical education and in physical activity, respectively. The rubrics were validated by the same research panel who revised the concept-mapping protocol. All panelists understood the expectancy-value theory, physical education, and physical activity. The validation process utilized 20% of the student responses selected at random.

Table 5. *Rubrics for Scoring Cost Responses*

Parameters to Consider in Scoring Cost Perceptions in PE:

(a) Number of costs and degree of cost reported on Item 12 and 13 of the Questionnaire:

- 0. [0-1 cost & lower degree perception = Lower cost]
- 1. [2 cost & lower degree perception = Moderate cost]
- 2. [1+ costs & higher degree perception = Higher cost]

(b) Scores of EBTV Motivation

- 0. [> 4.0 = Lower cost]
- 1. [$3.0-4.0$ = Moderate cost]
- 2. [$<.3.0$ = Higher cost]

(c) Intention for future enrollment with PE on Item 13 of the Questionnaire

- 0. [Positive intention = lower cost]
- 1. ["It depends" = Moderate cost]
- 2. [Negative intention = Higher cost]

Assign scores to each reference parameter individually and then average the coded scores. For instance, Senlin coded "2" for (a), "1" for (b), and "2" for (c), the final code is $(2+1+2)/3=1.67$.

0 No Cost

1 Moderate Cost

2 High Cost

Parameter to Consider in Scoring Cost Perceptions in PA:

Number of costs reported on Item 14 of the Questionnaire [The single reference parameter]

- 0. [0 cost]
 - 1. [1 cost]
 - 2. [>1 costs]
-

Note. Range of scale: 0 ~ 2

Each panelist read responses individually and generated two scores, one for perceived cost in physical education and one for perceived cost in physical activity. Next, a panel meeting was held to discuss the assigned scores. Scoring discrepancies were discussed at the meeting and consensuses from at least three panelists were reached. The validated rubrics categorized the two cost variables on a three point scale indicating low, moderate and high perceptions of cost in physical education or physical activity settings. Table 5 illustrated the rubrics for scoring cost responses. I finished scoring the rest of student responses independently by closely following the validated rubrics. A random 25% of student responses were scored twice to calculate intra-rater reliability. The intra-rater reliability ratios were .94 and 1.00 for cost in physical education and physical activity, respectively, which were very high.

Knowledge variable. The energy-balance knowledge was summarized using a modified concept-mapping scoring sheet developed by Novak and Musonda (1991). In their original scoring system for concept mapping, Novak and Musonda's (1991) categorized concepts and propositional links into three difficulty levels (Concepts: hard = 10; moderate = 5; easy = 2; Links: hard = 20; moderate = 10; easy = 5) and then judged the relevancy of the concepts, appropriateness of propositional links and misconceptions in reference to the scientific conceptions of the phenomenon. In this study, the same research panel that validated the rubrics for scoring cost responses decided not to create hierarchy of knowledge because the enclosed concepts were adopted from students' health education textbook and they were familiar with them all. Thus, all concepts were treated at the same knowledge level in scoring. In addition, since misconceptions about

energy-balanced living were rarely, shown in the completed concept maps, the panel decided to disregard misconceptions as a scoring variable. Instead, the panel emphasized concept cluster and concept proposition as the two key indicators for scoring. Two relatively scientific concept maps were created based on the two rounds of intensive discussions of the expert panel. The students' concept maps were then scored by assessing their deviations of concept clusters and concept propositions from the two referent concept maps. The two referent concept maps are illustrated in Appendix D. A seven-point scale was adopted for scoring the correctness of concept cluster and proposition. Table 6 illustrated the scoring rubrics for scoring students' completed

Table 6. *Rubrics for Scoring Concept Maps*

	0	Blank or no correct cluster
Scientifically Correct Concept Cluster (Write down the concepts in the right place)	1	1-4 correct clusters
	2	5-8 correct clusters
	3	9+ correct clusters
	0	Blank or no correct connection
Scientifically Correct Concept Propositions (Make and describe scientifically correct connections)	1	1-4 correct connections
	2	5-8 correct connections
	3	9+ correct connections

Note: Range of scale: 0 ~ 6

concept maps. Following the scoring guide, I independently scored the rest of student responses. A randomly selected 25% of completed concept maps were coded twice with

one day of interval to calculate intra-rater reliability. The intra-rater reliability ratio was .90, which demonstrated high reliability.

In-class physical activity. In-class physical activity level was recorded as vector magnitude (VM). The total VM was converted in VM per minute to reflect the intensity level of in-class physical activity. VM/min data were obtained through dividing sum of physical activity counts by the number of minutes.

After-school physical activity. The recalled after-school activity data were coded into categories of sports, fitness, other physical activity, sedentary academic behaviors, resting, sedentary entertainment, and socializing, shown in Appendix E. Sports, fitness, and other physical activity were further coded as physical activity behavior during data reduction; others sedentary behaviors. The total minutes of active time per day were estimated by multiplying total number of cells of physical activity with 15 minutes. A student's average time of after-school physical activity was computed by dividing the three-day total minutes by three.

Phase Four: Data Analysis

The reduced data were subject to the subsequent data analyses. Data were analyzed to answer three research questions: (a) To what extent does expectancy-value motivation contribute to energy-balance knowledge and physical activity? (b) To what extent did ninth grade students correctly constructed energy-balance knowledge? And (c) to what extent does energy-balance knowledge influence physical activity participation? Structural equation modeling was employed as the analysis approach to addressing research questions (a). The analysis consisted of two steps: confirmatory factor analysis

on the measurement model and the structural modeling on the path relations among variables. Mental model classification was utilized to address the research question (b); while logistic regression analysis was utilized to address the research question (c).

Confirmatory factor analysis. Confirmatory factor analysis is a statistical procedure to test measurement models that have been theoretically justified or supported (Kline, 2005). The purpose of using the analysis was to determine whether the construct

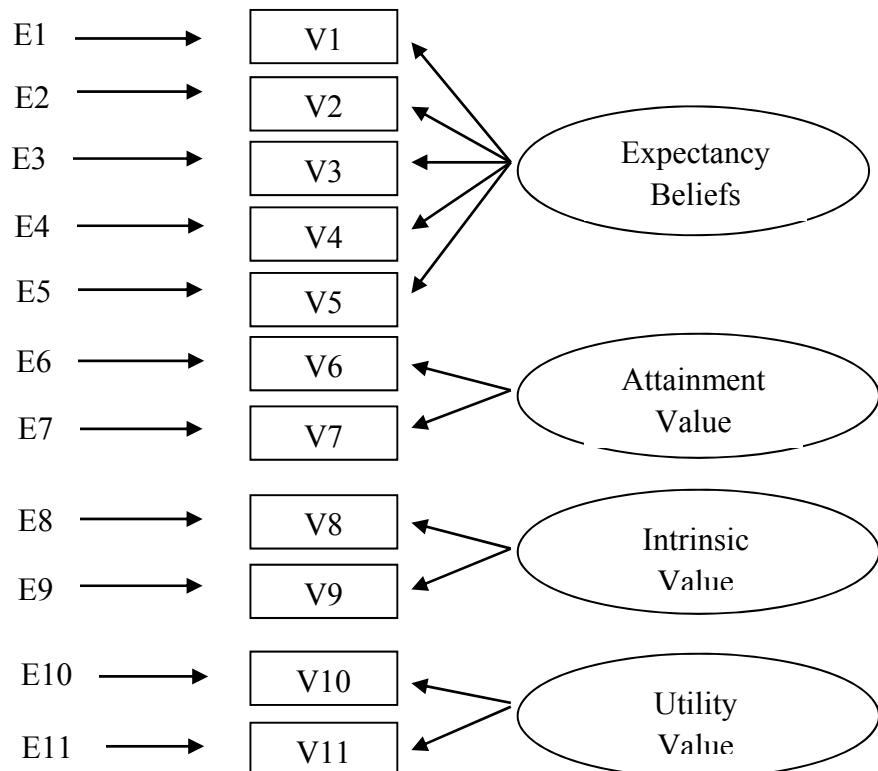


Figure 6. Measurement Model for Expectancy-Value Motivation. V1-V11: Question items corresponding to each latent variable; E1-E11: residual variances or unexplained errors.

validity of the Expectancy- Value Questionnaire was maintained in the current data.

As shown in Figure 6, factor loadings from the four latent variables to the 11 observed

variables and the residual variances (i.e., E1~11) were the parameters to be tested.

LISREL 8.8 served as the statistical tool for the confirmatory factor analysis. Model

indices of Chi-square ($p > .05$), root mean square error of approximation (RMSEA < .10;

Browne & Cudeck, 1993), and standardized root mean square residual (SRMR < .10;

Joreskog & Sorbom, 1989) were calculated to test model fit.

Structural equation modeling. The *a priori* structural model was specified as shown in Figure 7 to test the one-way directional relationships among the variables of expectancy-value, motivation energy-balance knowledge, and physical activity. The first research question was addressed using structural equation modeling. Specifically, expectancy-value motivation would contribute to energy-balance knowledge and physical activity. The model parameters to be tested consisted of path coefficients from expectancy beliefs, attainment, interest, utility, and cost to knowledge, in-class physical activity, and after-school physical activity. Chi-square ($p > .05$), RMSEA (< .10), and SRMS (< .10) were the indices adopted to test model fit on LISREL8.8. Alternative path models were tested to compare and contrast for both statistical and substantive meanings. The models with significant model fit indices and theoretical justifications retained as the final models.

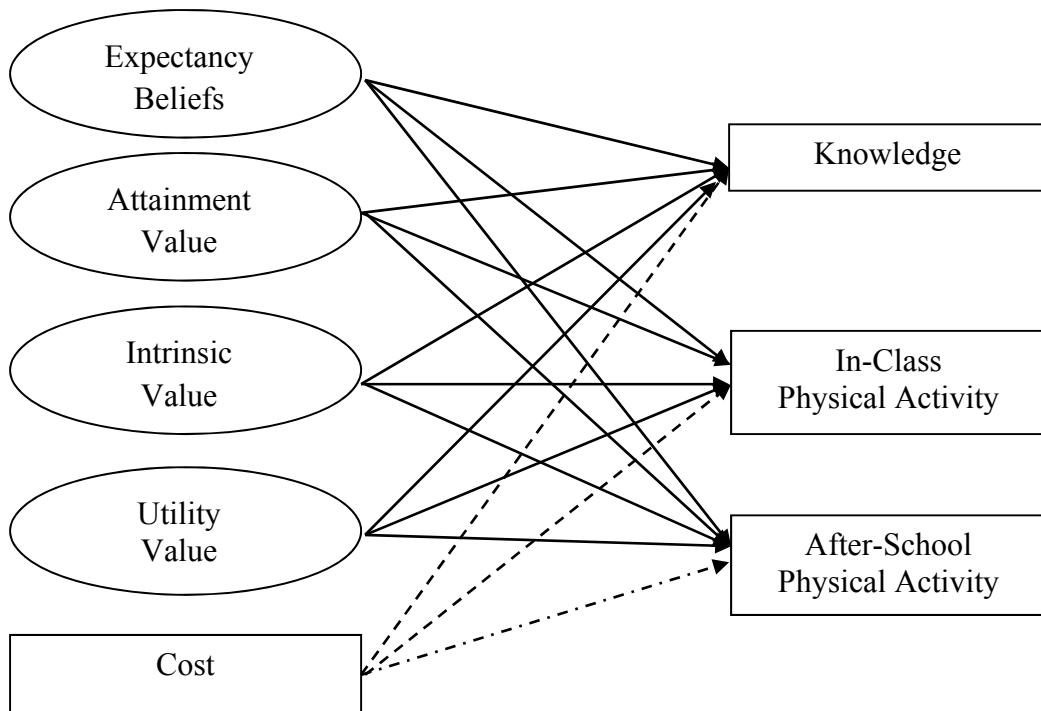


Figure 7. The *a priori* Structural Model. Solid arrows signify positive paths; while broken arrows signify negative paths.

Concept map classification. The second research question was addressed using concept map classification. Low (intuitive), medium (synthetic), and high (scientific) levels of concept maps about energy-balance knowledge were determined by the students' performance on concept-categorizing and concept-linking. The three concept-map levels were organized into a scoring matrix. Specifically, Level I concept maps were represented by low scores in both concept-categorizing and concept-linking; the Level III concept maps were represented by high scores in the two. The Level II concept maps were represented by other combinations of the two scores. Frequency and percentage of mental models at each level were compiled and concept map examples were analyzed and presented.

Logistic regression analysis. The third research question was addressed using the logistic regression. In-class physical activity and after-school activity (i.e., overall, sports, fitness, and other) were specified as the dependent variables; while concept-categorizing and concept-linking as independent variables. The 95% of confidence interval was set to test the hypothesis ($\alpha = .05$).

Potential Threat to Validity and Reliability with Strategies

Internal Validity Threat and Strategies

Several potential threats to internal validity of research were carefully addressed. First, all measurement instruments utilized in this research (i.e., Expectancy-Value Questionnaire, Three-Day Physical Activity Recall survey, GT3X accelerometer) were previously validated. To ensure the construct validity of expectancy-value motivation, a confirmatory factor analysis was conducted in this research. Sound factor loadings with satisfactory model fit indices should ensure motivation being well manifested by the factors of expectancy beliefs and task value. In addition, rubrics for scoring cost items and energy-balance knowledge were validated by an expert research panel. At least 90% of agreements were reached among panelists for each scoring rubric. Second, the proposed data collection protocol was closely followed during data collection. As the data collector, I trained myself by rehearsing data collection procedures multiple times before entering the research site. This has minimized the variations in administering the measures across classes.

External Validity Threat and Strategies

One potential threat to the external validity of this research lies in the sample representativeness. The participants were ninth grade students recruited from two homogeneous high schools. Like many ninth graders across the country, all participants were exposed to the multi-activity curriculum, although they might participate in varied activity or sports at different time of the year. In addition, the two schools' healthful living curriculum adopted the same textbook (Friedman et al., 2009), one of the four being adopted by the state of North Carolina for 9-12 grades. In this regard, nearly all the ninth graders in the state of North Carolina might have been exposed to the same content regarding energy-balance knowledge as enclosed in their textbook. Therefore, the research findings generated from these 195 participants can represent the larger population of ninth graders in the state of North Carolina and the country to some extent.

Reliability Threat and Strategies

The reliability of scoring cost responses and energy-balance knowledge may be a concern if not well addressed. To ensure the reliability, I scored and re-scored 25%

randomly selected worksheets to compute the intra-rater reliability. These reliability

coefficients all exceeded .90 and should be deemed as satisfactory.

In addition, students who have never worn the GT3X accelerometer before might react

differently when they first wear it during physical participation. To minimize students'

reactivity effect to the accelerometer and increase data reliability, a regular physical

education class was purposefully arranged for the participants to wear the device while

participating in the organized activities at least one day before the real assessment. This

arrangement enabled the students to become accustomed to the device and participate in regular physical activities without restriction.

CHAPTER IV

NINTH GRADERS' EXPECTANCY-VALUE MOTIVATION FOR PHYSICAL ACTIVITY AND ENERGY-BALANCE KNOWLEDGE

Abstract

Directing learners' motivation to moderate-to-vigorous physical activity and energy-balanced living is essential to developing a healthy lifestyle. The purpose of this study was to test an *a priori* model hypothesizing that expectancy-value motivation would contribute to physical activity and energy-balance knowledge. High school students in ninth grade ($N=195$) provided data on expectancy-value motivation, energy-balance knowledge, in-physical education and after-school physical activity. Data were analyzed using structural equation modeling. The structural equation models indicate that expectancy beliefs ($\gamma = .26, t = 3.77, p < .01$; $\gamma = .24, t = 3.29, p < .01$) and intrinsic value ($\gamma = .19, t = 2.73, p < .01$) positively facilitated in-physical education physical activity. In addition, cost perceptions in physical education negatively affected after-school physical activity ($\gamma = -.33, t = -3.81, p < .01$; $\gamma = -.39, t = -3.98, p < .01$), but positively linked to concept clusters in energy-balance knowledge structures ($\gamma = .25, t = 3.08, p < .01$). In-physical education and after-school physical activity may be influenced by different motivation sources and students' expectation for success and perceived values in physical education were not associated with energy-balance knowledge.

Introduction

Longitudinal evidence from research suggests that children and adolescents become less active as they grow older (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008). In developed societies, sedentary behavior is often coupled with easy access to food and excessive consumption of caloric energy that creates an energy imbalance leading to unhealthy body fat accumulation (Katz, 2010). To counter this unhealthy way of living, children and adolescents need to become self-motivated to learn knowledge and principles necessary for developing an energy-balanced living behavior. Self-initiated motivation refers to the drive to engage in a desired behavior based on a person's self-concept system (Chen & Hancock, 2006). Self-initiated motivators are independent from the immediate environment and are believed to remain effective under various circumstances. Meta-analysis findings (Chen, Chen, & Zhu, in press) revealed that expectancy beliefs and task values (Eccles & Wigfield, 1995) are strong self-initiated motivators in physical education.

Equally important to motivation, the conceptual understanding about the relationship between energy intake and expenditure in daily life is needed. Ennis (2007) contended the importance of nurturing "a sound mind in a sound body" (p. 139). Understanding the knowledge of energy-balanced living can lead to appropriate decisions for behavior change associated with either reducing energy intake or increasing energy expenditure, or both (Dunford, 2010; Katz, 2010). In this regard, using physical activity as a method of energy expenditure is contingent upon the degree of knowledge about energy balance. This knowledge is supposed to be learned in high school physical

education and/or health education. The above scholarly articulation from the literature assumes a facilitating relation between motivation and knowledge and behavior.

This study was designed to test the relation among high school students' expectancy-value motivation, energy-balance knowledge, and physical activity behavior. Figure 8 below is the hypothesized *a priori* model to be tested in this study. This model hypothesized expectancy-value constructs (the vertical middle portion) would be associated with students' energy-balance knowledge and physical activity behavior (the right portion).

The variables in oval shapes are latent measures. Variables in rectangle shapes are direct measures. Dashed lines signify hypothesized negative influences. Bolded solid lines on the right signify hypothesized positive influences. Other solid lines signify confirmatory paths. V1~13 are the component measures for latent measures. E1~13 are the residual variances unexplained by the latent factors. The following sections articulate each construct and their relationships hypothesized in the model based on current literature .

The Expectancy-Value Motivation

Eccles and Wigfield (Eccles et al., 1983; Eccles & Wigfield, 1995) developed the expectancy-value theory. The theory consisted of two major constructs: *expectancy beliefs* and *task values* that are interrelated but independent (Eccles & Wigfield, 1995). The expectancy beliefs refer to a self-conception of success in an activity such as learning. It taps into learners' perceptions of competence and control that determine the likelihood of success (Schunk & Zimmerman, 2006). Strong perceptions of competence and control

in learning an activity tend to enhance students' expectancy beliefs for success and consequently facilitate students' learning.

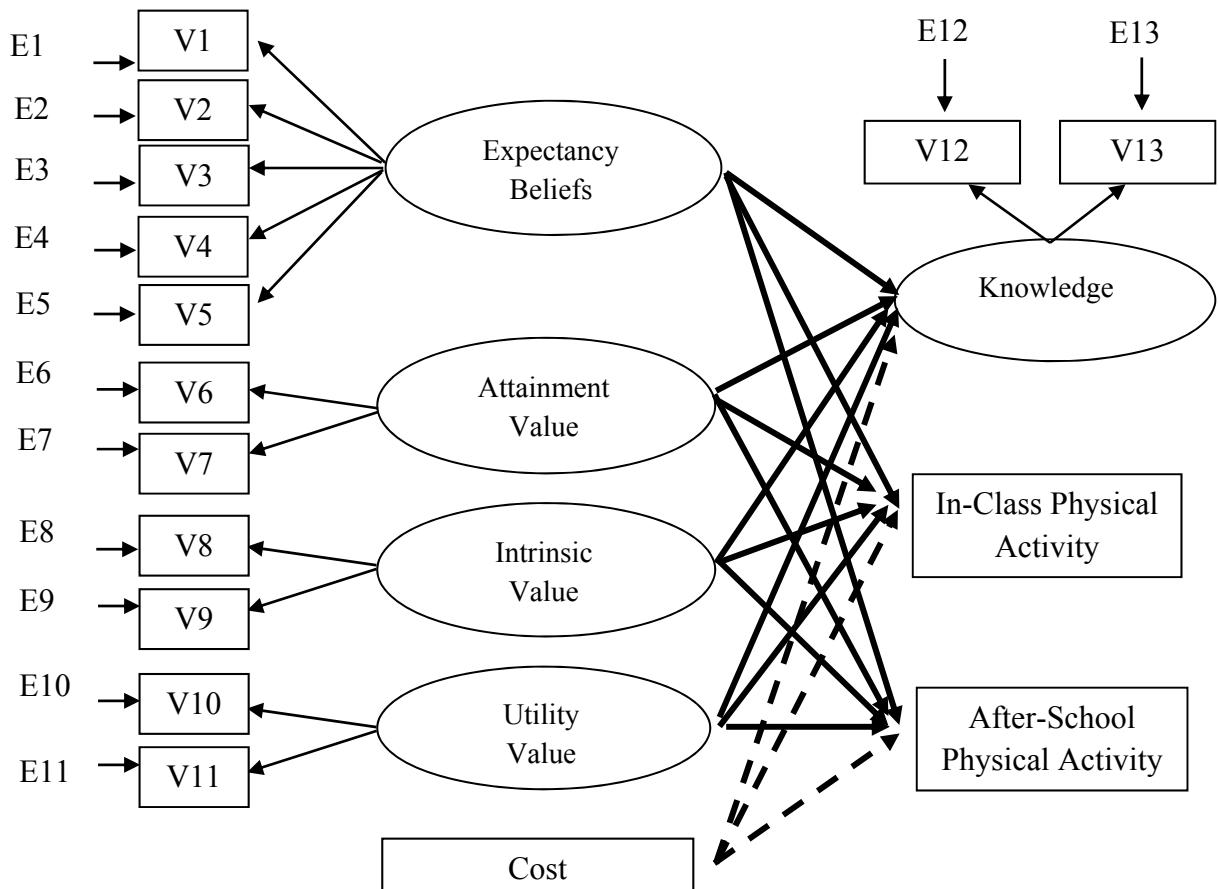


Figure 8. The *a priori* Structural Model for Analysis.

Task values address the subjective reasons for doing an activity (Pintrich & Schunk, 2002). *Attainment value, intrinsic value, utility value and cost* have been identified as components of the task value construct across academic areas and physical education (Eccles & Wigfield, 1995; Xiang, McBride, Guan & Solmon, 2003). Specifically, attainment value alludes to the perceived importance of doing well in

learning. The attainment value of physical education is acknowledged if a student considers it important to life. Intrinsic value refers to the extent to which the learning experience is enjoyable to students. A typical intrinsic value of physical education lies in the enjoyment many physical activities can provide. Utility value refers to the perceived usefulness of a content. Students tend to value physical education if they perceive it useful for their personal life. Cost refers to the expense or negative consequence of engaging in an activity (Eccles & Wigfield, 1995). Cost perceptions in physical education may be related to physical discomfort, boredom associated with task repetition, irrelevant curricula or perceived incompetence (Chen & Liu, 2009; Xiang, McBride & Bruene, 2006).

The function of expectancy beliefs and task values includes motivational impact on learning outcome measures in physical education. Xiang and colleagues (Xiang, McBride & Bruene, 2004) assessed fourth grade students' ($N = 119$) expectancy-value motivation and its relation to future intention for running and 1-mile run performance. The researchers found that intrinsic value ($\beta = .49$, $t = 5.78$, $p < .01$) and attainment value ($\beta = .30$, $t = 3.48$, $p < .01$) positively predicted intention for future participation in running, and that expectancy beliefs positively predicted performance on the 1-mile run test ($\beta = .32$, $t = 3.41$, $p < .01$). With a similar approach, Gao (2008) examined the relationships between expectancy-value motivation and a set of indicators: engagement, satisfaction, and cardiovascular fitness performance. Participants from sixth, seventh, and eighth grades ($N = 307$) completed self-report measures on motivation, perceived engagement and satisfaction, and participated in a standardized fitness test. It was found

that expectancy beliefs significantly predicted performance on the cardiovascular fitness test ($\beta = .32$, $t = 5.88$, $p < .001$); while expectancy beliefs ($\beta = .30$, $t = 2.38$, $p < .05$; $\beta = .24$, $t = 3.3$, $p < .05$), attainment value ($\beta = .31$, $t = 3.68$, $p < .001$; $\beta = .12$, $t = 2.42$, $p < .05$) and intrinsic value ($\beta = .24$, $t = 2.16$, $p < .05$; $\beta = .55$, $t = 9.32$, $p < .01$) positively affected engagement and satisfaction.

The construct of cost has received little research attention in comparison with expectancy beliefs and task values. Cost is often measured by open-ended questions (Eccles et al., 1983). Due to the non-numeric nature of the measure, some researchers chose not to collect cost data (e.g., Gao, 2008; Xiang et al., 2004). A few attempts were made, however, to quantify the open-ended cost responses and use them to identify negative dimensions of physical education as opposed to its values (Chen & Liu, 2009; Xiang et al., 2006). For example, Chen and Liu (2009) studied cost and their effect on motivation among Chinese college students ($N = 368$). The study found that the frequently reported cost included disappointment at the curriculum (45%), learner-unfriendly learning context (27%), irresponsible teachers, and de-contextualized assessments (12%). In addition, students' cost perceptions about the curriculum were found undermining intrinsic value ($F = 8.46$, $p = .004$, $\eta^2 = .24$). However, in spite of the cost perceptions, 90% of the students retained intention to take physical education in the future because of its values.

In summary, Gao (2008) and Xiang et al. (2004) demonstrated that the expectancy-value constructs are predictive of different outcome measures in physical education. Expectancy beliefs seem to be a strong motivator for performance-related

variables (e.g., 1-mile run, performance on fitness testing). In contrast, the task values are significant motivators for satisfaction, effort and engagement, and future decisions such as physical activity intention. Chen and Liu (2009) illustrated that cost had a detrimental effect on the perceived intrinsic value but did not compromise students' intention for future enrollment in physical education. The effect of cost on learning behavior and outcomes such as physical activity and knowledge of energy-balanced living remains unclear. Expectancy beliefs, task values and cost should be further articulated in research for a full understanding of their motivational implications.

Knowledge as Motivational Outcome

Conceptual knowledge is an important pedagogical content in physical education. Zhu and Chen (2010) investigated the influence of expectancy beliefs and task values on achievements in learning health-related fitness knowledge and overhand striking skills among sixth, seventh, and eighth grade students ($N = 854$). The comparison of pre- and post-tests revealed that the students acquired the knowledge ($d = .58, p < .05$) and skills ($d = 1.40, p < .05$). However, expectancy-value motivation had little effect on the achievement ($p > .05$). In another study, Chen and Chen (2010) investigated the triadic relationships among expectancy-value motivation, health-related fitness knowledge, and in-class physical activity in an elementary school sample ($N = 753$). The hierarchical linear modeling analysis found that in-class physical activity dictated knowledge learning ($t = 3.18, p < .01$) but mitigated the prediction of attainment value to knowledge learning performance ($t = -3.10, p < .01$). The evidence suggests that the learning context with moderate physical activity is desirable for knowledge acquisition.

In summary, research evidence has not revealed substantial direct effects of expectancy beliefs and task values on knowledge learning in physical education. Little evidence is available to address the direct relationship between expectancy-value motivation and physical activity behavior. Research studies are needed to clarify the relationship between expectancy-value constructs, conceptual knowledge, and physical activity behaviors in physical education.

Behavioral and Conceptual Perspectives on Learning

Learning is traditionally defined as behavioral changes that are relatively permanent and explicitly measurable (Rink, 2001; Shuell, 1986). Although skill development is a frequently used behavioral indicator to document behavioral change in physical education, moderate-to-vigorous physical activity has become another important indicator of behavior change. Physical activity can be measured by several different ways such as systematic observation (McKenzie et al., 2006), sensor-based technology (Chen, Martin, Sun, & Ennis, 2007), and self-report (Weston, Petosa, & Pate, 1997). Studies that focus on physical activity have helped us understand how active students are in reference to how active they should be (e.g., McKenzie et al., 2006).

Behavioral change is by no means the sole goal of physical education. Educational psychologists advocate that educators should emphasize learners' active role in interpreting, rather than passively internalizing, conceptual information derived from the interaction with the content (Murphy & Mason, 2006). This active process of interpretation is often characterized by a conceptual change through purposeful experiences where learners' current conceptual structures grow into increasingly

sophisticated structures (Murphy & Mason, 2006). Ennis (2007) summarized that students in physical education have misconceptions that may constrain their problem-solving skills, decision-making capabilities, and performances in games or other practical situations. In short, the way students learn in physical education can be conceptualized as a process of conceptual change.

The Present Study

By testing the hypothesized *a priori* model (Figure 8), this study examined the motivational implication of expectancy-value constructs for the energy-balance knowledge and physical activity in physical education and during after school hours. Specifically, the study was designed to answer the following question: To what extent did expectancy-value constructs affect energy-balance knowledge, in-class and after-school physical activity? As summarized above, expectancy beliefs, attainment, intrinsic, and utility values are adaptive motivators for students' learning behavior and outcomes in physical education. These constructs were hypothesized to positively influence energy-balance knowledge, in-class and after-school physical activity. In contrast, cost, as the negative component in the expectancy-value construct, was previously found attenuating learners' motivation. Thus, in this study, cost was hypothesized as a de-motivator that would undermine energy-balance knowledge, in-class and after-school physical activity.

Method

Settings and Participants

Schools. Two high schools in the southeastern U. S. were selected as the research settings. Specific to the purpose of the study, one criterion for school selection was that

the concepts of energy balance should have been taught to students. The two schools met this criterion. The two schools had similar characteristics on four key variables: race/ethnicity, ratio of students eligible for free or reduced lunch program, school size, and pupil/teacher ratio (Sable, Plotts, & Mitchell, 2010). Table 7 illustrates the detailed information for the two schools on these variables. They shared the same arrival and dismissal time but different number and length of class sessions. In each day, School A had four sessions of 90-minute-long classes, while School B had six sessions of 50-minute-long classes.

The curriculum. One credit hour of healthful living course that integrated physical education and health education was required by the target school district. In the two selected high schools, physical education was the main stem of the healthful living curriculum and was taught in three quarters of a school year. In a fourth quarter of the year, the students took turns to rotate out of physical education to study health education content in a classroom setting. The course was taught by certified physical education and health education teachers with teaching experiences ranging from seven to 28 years. The two schools adopted the multi-activity physical education curriculum that offered a variety of physical activities. The students experienced each activity for approximately two weeks. At the time of data collection, the students participated in running, shot put, ultimate Frisbee, football and/or pickleball. In a typical physical education class, the students started with warm-up routines that might include calisthenics, running or walking in laps, and/or stretching. Then, they were assigned into small groups and played

competitive games. The teachers emphasized participation and fun but rarely taught health-related scientific knowledge in the physical education lessons.

Unlike physical education, health classes were taught in traditional classroom. The health education content revolved around a textbook required by the state (Friedman,

Table 7. *Information about the Two Selected Schools*

	<i>School A</i>	<i>School B</i>
Race/Ethnicity		
<i>Whites</i> %	39%	43%
<i>Other</i> %	61%	57%
Free/Reduced Meal	42%	39%
Pupil/Teacher Ratio	16.3:1	15.2:1
Average School Size	1842	1497

Stine, & Whalen, 2009). The textbook covered six instructional units: (a) heath and wellness, (b) health and body, (c) drugs, (d) diseases and disorders, (e) adolescence, adulthood, and family life, and (f) reproductive health. Content about energy-balanced living was articulated in a chapter pertaining to weight management and eating behaviors. In a health class, the students sat in their assigned seats quietly as soon as the bell rang. To instantly calm down the students, the teacher often had two or three questions written on the whiteboard for students to respond independently with pencil and paper. Health-related content then was conveyed via lectures with Power Point or overhead projector

presentations. Students took notes of the lectures to receive in-class quiz points. Group or class discussions occasionally occurred with the teachers questioning students and students voicing yes/no or explanatory answers. Homework was assigned from time to time for formative assessment.

Participants. The participants were 195 students from 12 ninth grade classes. More girls ($n = 115$) than boys ($n = 80$) participated in the study. Race/ethnicity data were not collected because of school district's restrictions on collecting and using student demographic data for research purposes. All data were collected from students whose parents consented their participation and who assented for participation. The study was approved by the University Institutional Review Board and the Research Committee of the school district in which the two selected schools were located.

Variable and Measures

Expectancy-value motivation. The modified *Expectancy-Value Questionnaire* (Zhu, Chen, Sun, & Ennis, 2009) was used to measure students' expectancy beliefs and task values. Expectancy beliefs were measured by five items. An example is, "How good are you in physical education?" (1 = *not good*, 5 = *very good*). Each of the three perceived task values was measured by two items. For example, an item measuring the attainment value was "Compare to math, reading, and science, how important is it for you to learn PE?" (1 = *not very important*, 5 = *very important*). Cost was measured by three open-ended questions asking about cost perceptions in physical education and in physical activity settings. One example item for cost was "If there is anything that you don't like in PE, what would that be? Why?" The questionnaire demonstrated high construct

validity and reliability in previous research (Cronbach $\alpha = .60$ and $.74$ for expectancy beliefs and task values, respectively: Xiang et al., 2003; Latent structural reliability coefficient $\rho = .91$: Zhu et al., 2009).

Energy-balance knowledge. Concept-mapping was used to measure students' understanding about the energy-balance knowledge. It is believed that learning takes place by "the assimilation of new concepts and propositions into existing concept and propositional frameworks held by the learner" (Novak & Canas, 2009, pp. 3). In this study, concept-mapping was used to determine the extent to which learned knowledge is organized and represented in mental networks characterized by concept clusters and concept propositions (Novak, 2005; Novak & Canas, 2008; Novak & Musonda, 1991). Two content analyses were conducted to select the core concepts that reflect the relational knowledge of energy balance. A total of 16 core concepts related to energy balance, shown in Table 8, were extracted for concept-mapping from the health education textbook that the two high schools used (Friedman et al., 2009). Previous research demonstrated that concept-mapping could generate valid and reliable data on students' knowledge and knowledge structures (McClure, Sonak, & Suen, 1999; Novak & Musonda, 1991).

In-class physical activity. In-class physical activity was assessed using ActiGraph GT3X accelerometers (ActiGraph, Shalimar, FL). The accelerometer is a small ($1.50 \times 1.46 \times .71$ inches), light (0.95 oz) device housed in a plastic case. It measures and records physical activity counts in three physical axes. The intensity of physical activity (low, moderate, high or very high) was determined according to the

cutoff points categorized by Sasaki, John and Freedson (2010) (light: count < 1952; moderate: 1953-5724; high: 5725-9498; very high: > 9498). The device demonstrated high intra-instrument reliability ($r = .86$) and inter-instrument reliability ($r = .86 - .89$) (Melanson & Freedson, 1995).

Table 8. *The Energy-Balance Concepts for Concept-Mapping*

Concepts			
Energy Balance	Energy Intake	Energy Expenditure	Food
Beverage	Obesity	Weight increase	Weight Loss
Fat	P.E.	Physical Activity	Metabolism
Carbohydrate	Protein		

Note. Concepts extracted from Chapter 8 of Friedman et al. (2009).

After-school physical activity. Voluntary physical activity during after-school hours was measured using the modified *Three-Day Physical Activity Recall* (Weston et al., 1997). The instrument, shown in Table 3, has been used to provide a proximate measure of physical activities in the free-living condition in population-based studies (e.g., Pate, Ross, Dowda, Trost, & Sirard, 2003; Weston et al., 1997). The instrument provides a grid divided into 15-minute segments or blocks in which students recall and record all activities occurred between 3:00 and 10:00 p.m. It listed common activities grouped into the following categories: sport, fitness, other physical activities, academic/homework, rest, entertainment, and socialization. For each 15-minute block, students entered the main activity that they participated in. The main activity was defined as one that occupied most of the 15-minute period. The instrument demonstrated strong

evidence for test-retest reliability ($r = .98$) and concurrent validity ($r = .77$ with accelerometers) in previous research (McMurray et al., 2004; Weston et al., 1997). Further, as the physical activity recall period extended from one day to three days, researchers were able to obtain a more reliable estimate of voluntary physical activity (Trost, 2001).

Data Collection

A data collection protocol was established and followed. Three sets of activities occurred procedurally. The expectancy-value questionnaire and concept-mapping were administered first. In-class physical activity level was measured next; followed by the three-day after-school physical activity survey. The entire data collection lasted for five weeks with at least a one-day interval between any two data collection sessions. With the assistance from the teachers, all data collection went in an orderly manner. The sequenced procedures helped preserve the validity of measures by preventing students from changing their physical activity patterns as a result of responding to the motivation questionnaire and energy-balance concept-mapping. The teachers remained in the research setting during data collection to provide managerial assistance. The students were instructed to direct their questions to the researcher quietly anytime during the data collection.

Expectancy-value questionnaire. The questionnaire was administered at the beginning of a physical education class. Students were informed of the purpose of the questionnaire and to respond honestly and independently. They were also informed that there was no right or wrong answers to the questions and responses would remain

confidential and have no influence on their grades or school standing. Students were asked to sit five feet apart from each other on the gymnasium floor and to work independently.

Concept-mapping procedures. The validity and reliability of concept mapping rely on examinees' mastery of the procedures during data collection (Novak & Canas, 2008). A practice session of concept-mapping was conducted prior to the data collection in order to increase students' familiarity with the procedures. In the practice session, students were asked to create a concept map with concepts about dogs: *Whine, growl, bark, dog sounds, dogs, body parts, tail, paws, ears, fur, run away, scratch, breeds, Beagle, dogs behaviors, Collie, Scottie*. They were asked to accomplish three tasks: (a) clustering concepts by spreading them out in an open space on the worksheet, (b) drawing lines or arrows for every identified relation, and (c) adding written explanations using relational phrases for each linked relation. Once the above procedures were complete, they were prompted to revise their concept maps by checking if they had included (used) all concepts, made links to reflect all relevant relations among the concepts, and written brief explanations for the links. During the practice, the researcher read aloud the concepts and the above three tasks one by one. As it was a practice session, procedural assistance and verbal hints were provided. Open questions and discussions among the students were allowed during the practice to improve understanding of the mapping procedure.

Following the practice session, the same protocol was utilized to conduct concept-mapping for energy-balance concepts. The students were instructed to follow the

procedures (but no verbal hints or group discussions) they experienced in the practice session to complete the energy-balance concept-mapping. The researcher checked students' work in progress constantly during the process to ensure that they were using the techniques and procedures correctly. Questions about the procedures from the students were addressed immediately during the data collection. No verbal hints or group discussions were permitted during the data collection.

Accelerometer data. Prior to collecting in-class physical activity data, students had the opportunity to practice on how to wear Actigraph accelerometers. Wearing the devices, the students participated at least in one regular physical education lesson during the practice period. This procedure was useful for students to get used to the equipment when moving around to complete physical education tasks. It thus helped minimize the effect of reactivity (Heppner, Wampold & Kivlighan, 2008) and improved the data reliability. Before data collection began each time, the accelerometers were fully charged on battery and programmed for speedy activation and transition between lessons. On data collection days, the devices were distributed to individual students at the beginning of each lesson. Students wore the devices during the entire class and then returned them to the researcher when the lesson was over. In-class physical activity was assessed twice for each class. Data were uploaded to a data computer at end of each data collection day.

After-school physical activity data. Students were instructed to recall their physical activity on the Three-Day Physical Activity Recall instrument. Two week days and one weekend day were selected for the recall. The data collection was completed in physical education classes. On the day prior to the data collection, the students were

instructed to pay attention to the types and durations of activities that they would participate in during after-school hours that day. On the following day, they were asked in physical education to document the activities on the data collection sheet. During the data collection, the structure of the instrument was explained again to fill each 15-minute time slot. Students were instructed to recall and record honestly and independently. All questions from the students were addressed immediately during the data collection. The same procedures were repeated on two other days until all three days of recalls were completed.

Data Reduction

Expectancy-value motivation. Responses to the expectancy beliefs, attainment value, intrinsic value, and utility value were aggregated by dimensions. For example, the five items for expectancy beliefs were aggregated and averaged to represent the dimension of expectancy beliefs. Responses to the three open-ended cost items were scored according to a set of rubrics that was validated by a panel of four researchers in pedagogical kinesiology. All panelists understood the expectancy-value theory, physical education, and physical activity who had previously participated in similar process validating knowledge acquisition data scoring systems in a large, federally funded research. They all recently had presented their rubric development/application research at national conferences. In this study, the validation process utilized 20% of the student responses selected at random. Each panelist read the responses individually and generated the scoring rubric scaling system for cost perceptions in physical education and in physical activity. The system was on a 3-point scale with higher scores indicating higher

cost perceptions. Next, a two-hour long panel meeting was held to discuss the rubric system. Scoring discrepancies were discussed at the meeting and consensus from at least three panelists was reached for each discrepancy. Table 5 illustrates the rubrics for scoring cost responses. The researcher scored the rest of student responses by closely following the validated scoring rubrics.

Energy-balance knowledge. The energy-balance knowledge was summarized using a modified concept-mapping scoring sheet developed by Novak and Musonda (1991). Novak and Musonda (1991) categorized concepts and propositional links into three difficulty levels (Concepts: hard = 10; moderate = 5; easy = 2; Links: hard = 20; moderate = 10; easy = 5) and then judged the relevance of the concepts, appropriateness of propositional links and misconceptions in reference to the scientific conceptions. In this study, the same research panel that developed and validated the rubrics for cost responses also created and validated the scoring sheet for concept-mapping. The validation process utilized 20% of completed concept maps selected at random. The panelists reviewed the completed concept maps independently and then discussed them at a meeting. Upon discussion, the panel decided not to score the maps on knowledge levels and misconceptions; because the concepts adopted from the health education textbook were at the similar level of difficulty and it was unlikely that there were misconceptions in the textbook. Instead, the panel emphasized the correctness of concept clusters and concept propositions as the two key indicators of knowledge. A concept cluster is operationalized as the group of concepts that assumes a potential relation. A concept proposition was scored as the relation between every two concepts with a labeled

explanation. Table 6 illustrates the rubrics for scoring students' completed concept maps. Concept cluster and concept proposition were scored on the 3-point scale separately and the latent variable of knowledge was created by aggregating the two scores. Shown in Appendix D, two relatively scientific concept maps were created after the discussion of the expert panel. The correctness of concept clusters and propositions were judged based on the extent to which the students' individual concept maps deviated from these two referent concept maps. Following the validated scoring sheet, the researcher scored independently the rest of student responses.

In-class physical activity. The accelerometers data were saved electronically in the data computer. These raw data were then converted into activity count/minute to reflect the intensity level of in-class physical activity. Count/minute data were obtained through dividing sum of physical activity counts by the number of minutes.

After-school physical activity. After-school activity time data were coded into categories of sports, fitness, other physical activity, sedentary academic behaviors, resting, sedentary entertainment, and socializing. Sports, fitness, and other physical activity time were further aggregated as the overall physical activity time; while other activities were coded as sedentary activity time. The average daily physical activity time was computed by dividing total physical activity minutes by three (days).

Data Analysis

Validity and reliability. Validity and reliability of the instrument measures were calculated prior to the data analysis. First, intra-rater reliability coefficients were established by re-scoring a randomly selected 25% cost responses and concept-maps. The

Pearson product-moment correlation coefficients (r) were used to determine the reliability. Second, construct validity of the expectancy-value questionnaire and energy-balance knowledge was assessed using confirmatory factor analysis. The LISREL 8.8 was employed to operate the analysis. Third, statistical assumptions for structural equation modeling were tested for potential violations. The assumption tests were conducted on PRELIS, a built-in function of LISREL8.8.

Structural equation modeling. The *a priori* structural model, shown in Figure 8, was analyzed by testing the paths from expectancy-value motivation constructs to energy-balance knowledge, in-class and after-school physical activity. LISREL 8.8 was employed to test the model in which correlation matrices based algorithms were used. The original model and alternative models were tested to fulfill theoretical and substantive justifications. Model indices of Chi-square ($p > .05$), root mean square error of approximation (RMSEA < .10; Browne & Cudeck, 1993), comparative fit index (CFI > .95; Bentler, 1990), and goodness of fit index (GFI > .90; Joreskog & Sorbom, 1989) were calculated to test the extent of model-data fit. The full information maximum likelihood estimation was utilized to handle the small portion of missing values in structural equation modeling (Enders, 2009).

Results

Validity and Reliability

The Pearson product-moment correlation revealed that the intra-rater coefficients based on random 25% of student responses reached or exceeded .90 (Cost in physical education: $r = .94$; Cost in physical activity: $r = 1.00$; Concept maps: $r = .90$). This

indicates that the researcher scored consistently the responses. In addition, shown in Figure 9, confirmatory factor analysis found satisfactory construct validity for the expectancy-value questionnaire and energy-balance knowledge. The expectancy beliefs, attainment value, intrinsic value, and utility value stood tenable as the four latent

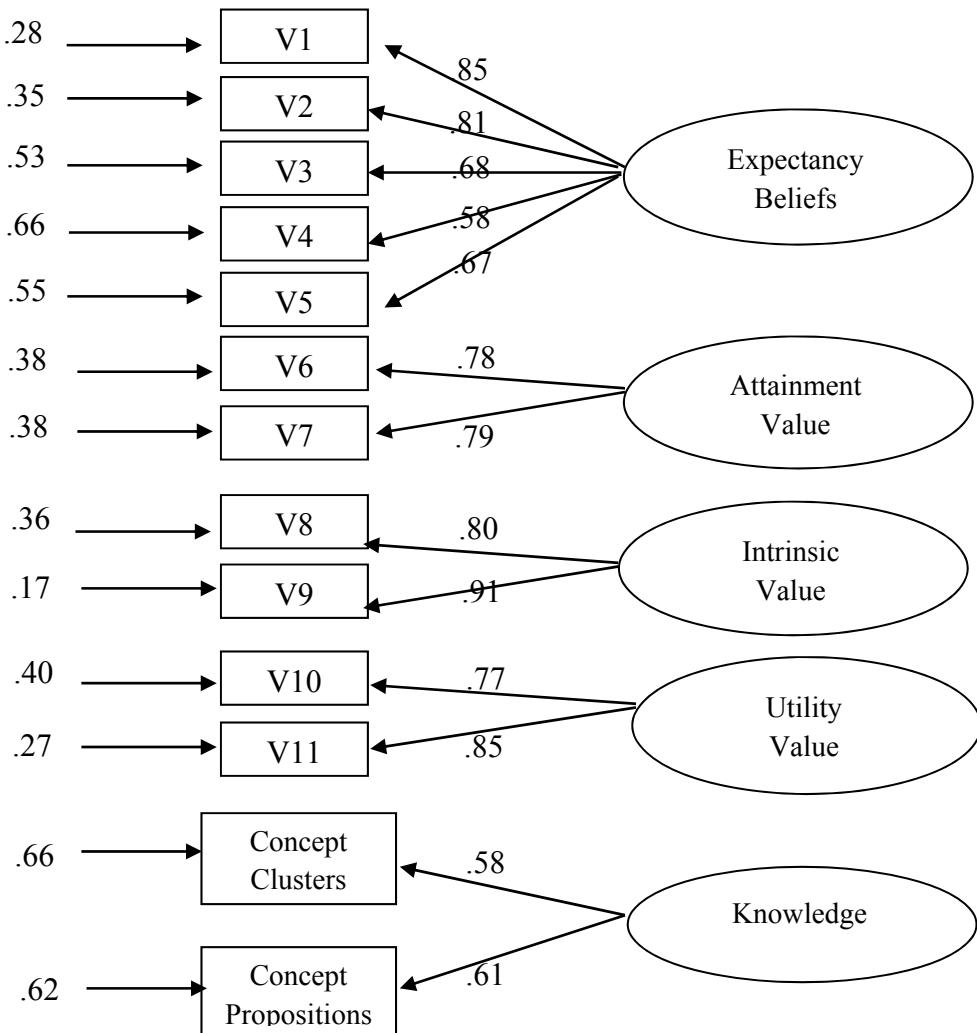


Figure 9. The Measurement Model. V1~V11 are the observed variables corresponding to the latent factors. Model fit indices: $\chi^2_{55} = 117.92$ ($p < .07$); RMSEA = .08, 90% CI (.06, .10); SRMR = .07.

variables for the questionnaire (Expectancy beliefs: Cronbach $\alpha = .58 \sim .73$; Attainment value: $\alpha = .77, .78$; Utility value: $\alpha = .79, .91$; Intrinsic value: $\alpha = .76, .86$; All residual variances except three items for the expectancy beliefs were lower than .50. The factor of energy-balance knowledge was marginally tenable with concept clusters and concept propositions as observed variables ($\alpha = .58, .61$).

Descriptive Results

Table 9 presents the descriptives for expectancy-value motivation, energy-balance knowledge and physical activity. The students reported relatively high expectancy beliefs and task values. Of all dimensions, expectancy beliefs received the highest scores, which suggest that the students believed they would be successful in physical education. Cost perceptions were, on average, relatively low in both physical education and physical activity. The concept-mapping scores demonstrated moderate performance. Concept clustering score was over twice as high as that on propositional linking. In-class physical activity on average was light (light: count < 1952; moderate: 1953-5724; high: 5725-9498; very high: > 9498; Sasaki et al., 2010). The students spent approximately 80 minutes per day participating in sports, fitness activities and other physical activities during after-school hours, which exceeded the recommended 60 minutes per day (USDHHS, 2000). All variables appeared at least symmetrical. The skewness and kurtosis values fell within or approximated the threshold values of -1.00~1.00.

Table 9. *Descriptive Information of the Variables*

	<i>N</i>	<i>M</i>	<i>SD</i>	<i>Scale</i>	<i>Skewness</i>	<i>Kurtosis</i>
Expectancy Beliefs	167	4.07	.70	1-5	-.62	-.41
Attainment Value	169	3.43	1.13	1-5	-.47	-.59
Intrinsic Value	171	3.67	1.07	1-5	-.51	-.45
Utility Value	170	3.58	1.01	1-5	-.37	-.45
Cost in Physical Education	165	.67	.55	0-2	.64	-.42
Cost in Physical Activity	160	.66	.57	0-2	.16	-.67
Knowledge	173	3.46	1.63	0-6	.09	-1.00
Concept Clusters	173	2.35	.81	0-3	-1.13	.60
Concept Propositions	173	1.10	1.16	0-3	.46	-1.32
In-class Physical Activity	190	1890	604	0-	.98	.91
After-School Physical Activity	195	79.03	62.37	0-	.71	-.05

Structural Equation Modeling Results

Figure 10, Figure 11, Figure 12 and Figure 13 show the results from structural equation modeling. These figures presented the original and alternative models based on theoretical and substantive justifications. Specifically, Figure 10 illustrates the original, a priori model, in which expectancy beliefs, attainment, intrinsic and utility value were hypothesized to positively contribute to energy-balance knowledge (as a latent factor), in-class physical activity, and after-school physical activity; while cost perceptions negatively contributing to these outcome variables. The results revealed that expectancy

beliefs positively contributed to in-class physical activity ($\gamma = .24$, $t = 3.12$, $p < .01$), and that cost in physical education negatively affected after-school physical activity ($\gamma = - .38$, $t = - 3.81$, $p < .01$).

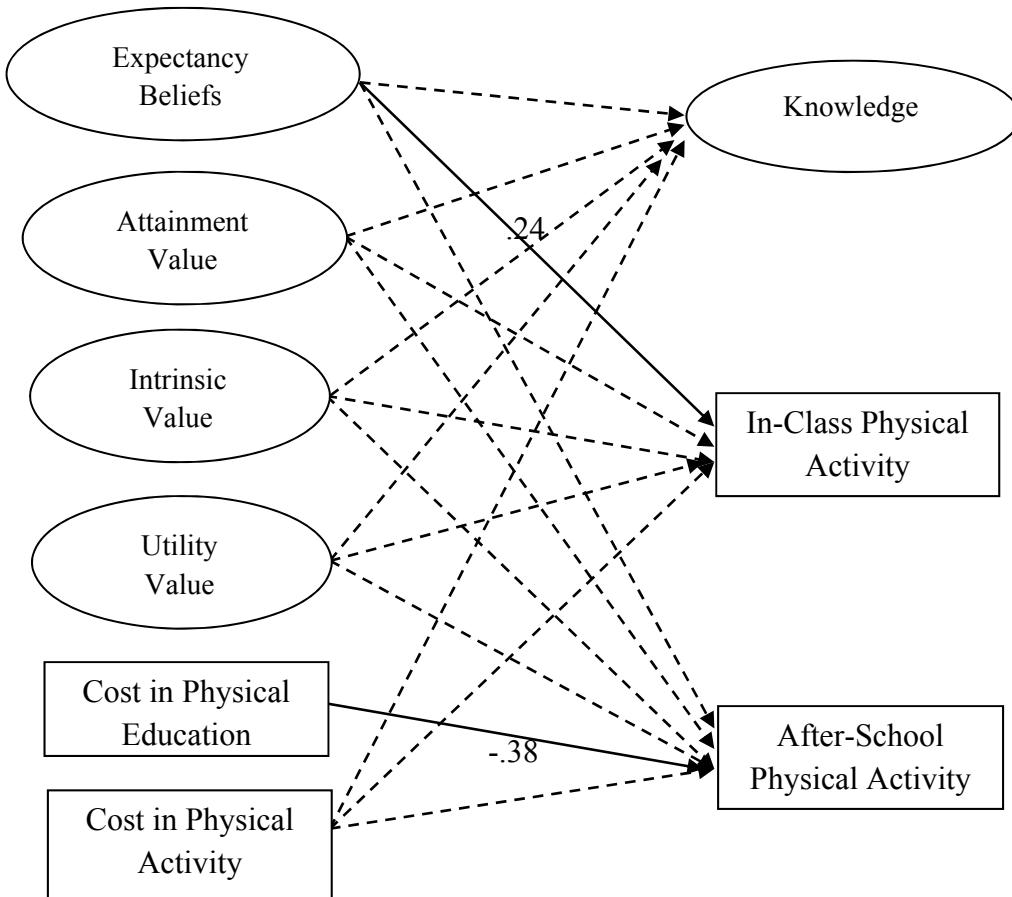


Figure 10. Structural Model 1. Solid arrows signify statistically significant paths. Broken arrows signify statistically non-significant paths.

Model 1 was statistically saturated and required modification. Based on modification indices provided by LISREL output, an alternative model reduced from Model 1 was created to test the links within the model that were most likely to be theoretically relevant. A separate test of the alternative model, Model 2, was conducted.

Shown in Figure 11, Model 2 included the paths from expectancy beliefs and intrinsic value to in-class physical activity, and the paths from attainment value, intrinsic value, and cost in physical education to after-school physical activity. This reduced model appeared to have good model fit ($\chi^2_{13} = 14.90, p = .31$; RMSEA = .03, 90% Confidence interval: .00, .08, $p = .70$; SRMR = .06). The results revealed that expectancy beliefs ($\gamma = .26, t = 3.77, p < .01$), and intrinsic value ($\gamma = .19, t = 2.73, p < .01$) positively contributed to in-class physical activity; while cost in physical education alone negatively contributed to after-school physical activity ($\gamma = -.33, t = -3.81, p < .01$).

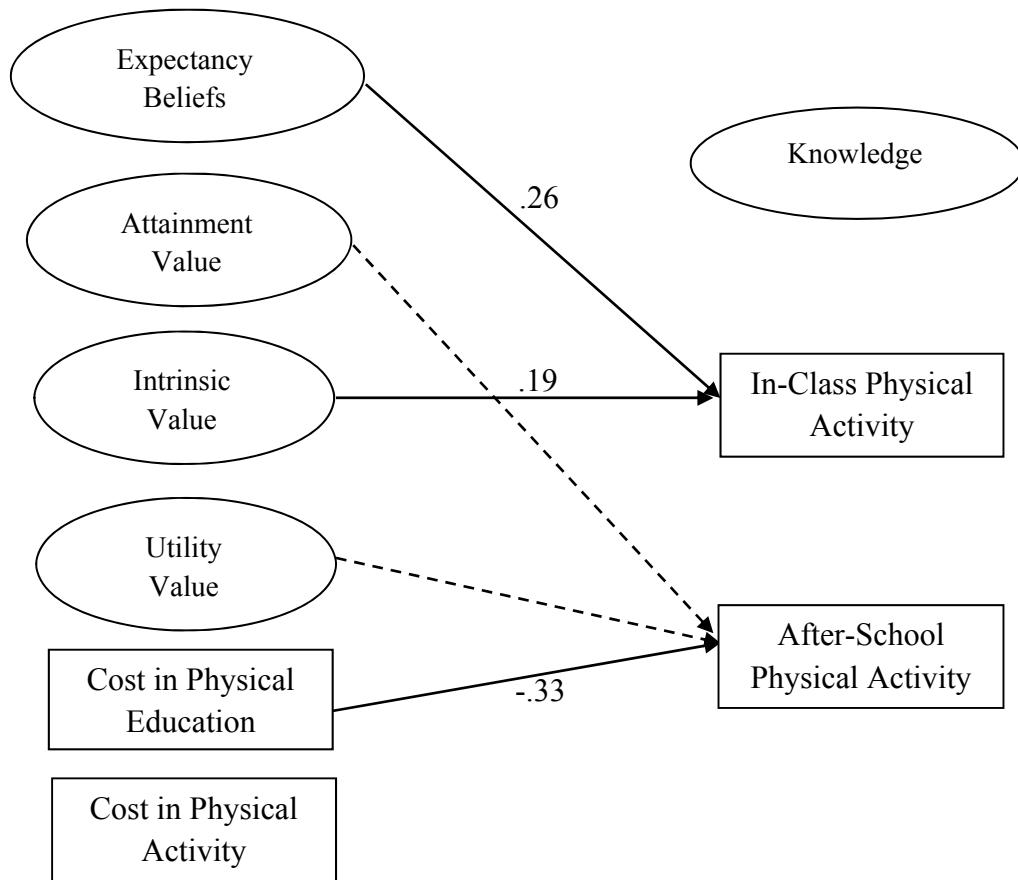


Figure 11. Structural Model 2. Solid arrows signify statistically significant paths.

Further, as the students performed dramatically better on concept clusters than concept propositions, shown in Table 9, it was necessary to identify the motivational effects of expectancy beliefs and task values on these two sub-categories of energy-balance knowledge, respectively. Thus, alternative Model 3 and 4 were generated and analyzed. Figure 12 illustrates the results of Model 3, which differed from Model 1 in that the observed variables of concept-categorizing and concept-linking replaced the latent variable of energy-balance.

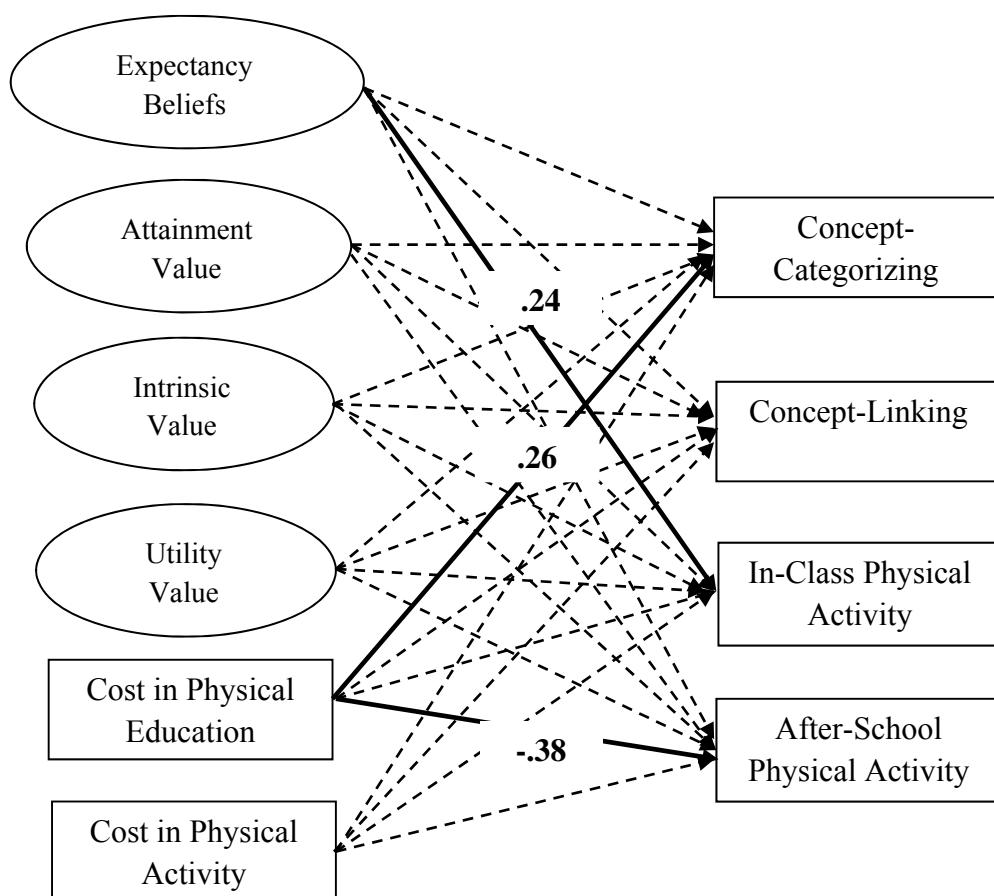


Figure 12. Structural Model 3. Solid arrows signify statistically significant paths. Broken arrows signify statistically non-significant paths.

Similar to Model 1 results, Model 3 also identified the significant path from expectancy beliefs to in-class physical activity ($\gamma = .24$, $t = 3.12$, $p < .01$) and the significant path from cost in physical education to after-school physical activity ($\gamma = -.38$, $t = -3.81$, $p < .01$). It further identified the significant path from cost in physical education to concept-categorizing ($\gamma = .26$, $t = 2.50$, $p < .05$). However, Model 3 was statistically saturated and required modification. Based on modification indices provided by LISREL, Model 4 was created and tested.

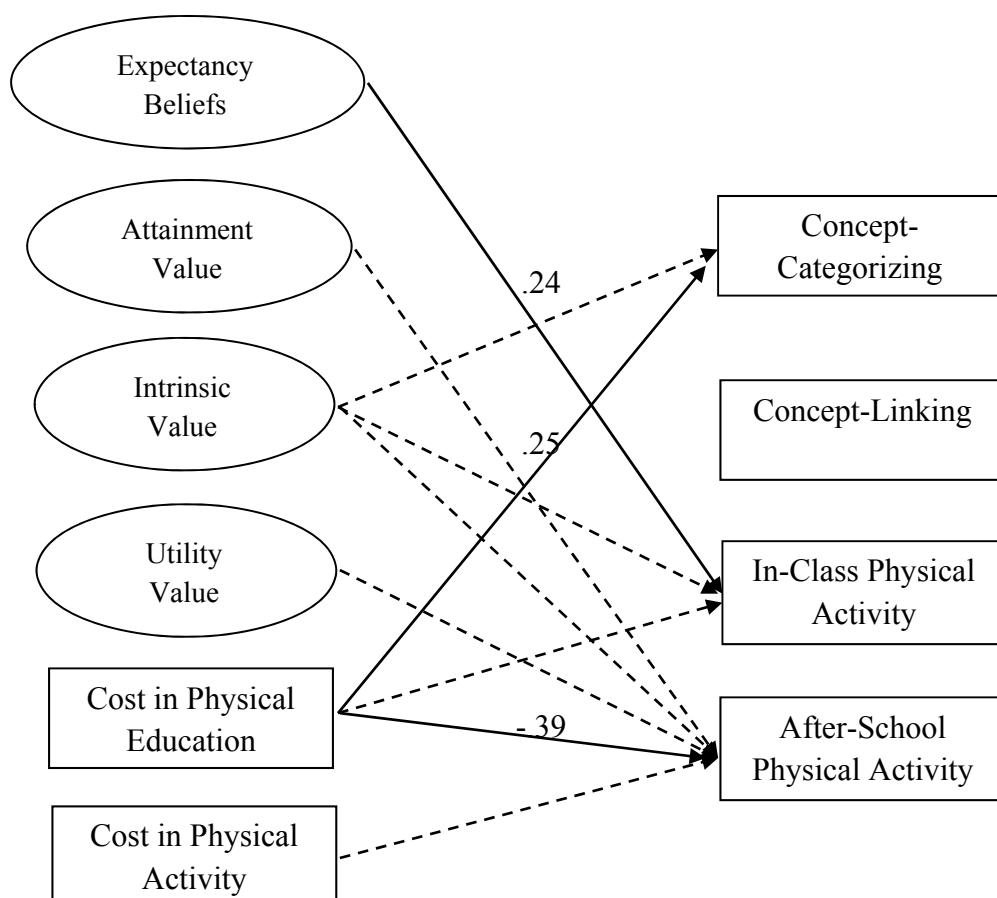


Figure 13. Structural Model 4. Solid arrows signify statistically significant paths. Broken arrows signify statistically non-significant paths.

Figure 13 presents the results of Model 4 that tested the paths from expectancy beliefs, intrinsic value, cost in physical education to in-class physical activity, the paths from intrinsic value, cost in physical education to concept-categorizing, and the paths from attainment value, intrinsic value, utility value, cost in physical education and cost in physical activity to after-school physical activity. This reduced model demonstrated good model fit ($\chi^2_{14} = 7.46, p = .91$; RMSEA = .00, 90% confidence interval: .00, .03, $p = .99$; SRMR = .04). It was found that expectancy beliefs ($\gamma = .24, t = 3.29, p < .01$) positively contributed to in-class physical activity, and that cost in physical education negatively contributed to after-school physical activity ($\gamma = -.39, t = -3.98, p < .01$) but positively contributed to concept-categorizing ($\gamma = .25, t = 3.08, p < .01$).

Discussion

This study was designed to examine the extent to which expectancy-value motivation affected energy-balance knowledge, in-class physical activity, and after-school physical activity in ninth grade physical education. The study found that expectancy beliefs and intrinsic value positively affected the in-class physical activity, cost perceived in physical education negatively affected after-school physical activity but positively affected concept clusters. The findings painted a complex picture about the relationship among expectancy-value constructs, energy-balance knowledge and physical activity behaviors.

Motivation for In-Class Physical Activity

Self-initiated motivation is pivotal for students' learning behaviors (e.g., physical activity) in physical education (Chen & Ennis, 2009; Chen & Hancock, 2006). In this

study, expectancy beliefs and intrinsic value were found to significantly contribute to the students' in-class physical activity. The expectancy beliefs function for adolescent students to make decisions on choice, effort and persistence by estimating the likelihood of success. Intrinsic value motivates adolescent students through enticing the feeling of enjoyment. It appears these two motivation constructs did function well in this group of students as evidenced in the models (Model 2 in Figure 11).

The expectancy beliefs for success tap into learners' perceived competence and control that are associated with learning (Schunk & Zimmerman, 2006). Harter (1978) posited that humans tend to engage in tasks that they think they are good at to perceive and demonstrate competence. In physical education or physical activity settings, perceived competence might be even more important than one's actual competence because the belief about competence to achieve may exert stronger motivational impact than the actual competence would. Perceived competence, as a motivator, has been identified as one of the strongest correlates of moderate-to-vigorous physical activity (See literature review by Wallhead & Buckworth, 2004). The second essential component of expectancy beliefs for success is perceived control. Previous research documented that learners would become motivated if they believe they could control the learning process and outcome. For example, Ennis (1999) reported that providing a sense of ownership to female students and under-skilled male students would create a context in which the students were likely to develop a feeling of control. The perceived control enabled the students marginalized in the traditional physical education environment to actively engage in the curriculum.

There should be no doubt that enjoyable experiences are motivational for in-class engagement in physical education. The students in this study reported moderate to high scores on the intrinsic value which, in turn, led to increased in-class physical activity. The finding indicated that the students recognized the intrinsic values of the physical activities and were motivated by the value. This finding is consistent with previous research conclusions (O'Reilly, Tompkins & Gallant, 2001) that interesting or fun experiences in physical education are the most salient motivational characteristics of the content. Although measured differently, intrinsic value does share the characteristics of interest (Hidi, 2000). Interest, as a natural motivator, has been found predictive to achievement in learning fitness knowledge and sport skills (Shen & Chen, 2006; Shen, Chen, & Guan, 2007). Hidi and Renninger (2006) proposed that educators should build interest into learning tasks to help students internalize the value of content.

Motivation for After-School Physical Activity

Motivating students to develop and sustain regular, voluntary physical activity participation is a primary goal of physical education (Chen & Hancock, 2006; Ennis, 2010). Prior research has indeed identified a positive role of motivation in performing moderate-to-vigorous physical activity during leisure time (e.g., Cox, Smith, & Williams, 2008). However, cost perceived in engaging in physical activities might cast a potentially negative influence on adolescents' motivation in physical education on leisure-time physical activity (Chen & Liu, 2009). The present study revealed that cost perceived in physical education undermined the students' physical activity participation during after-school hours. This finding urges physical education professionals to look at the issue of

cost possibly hidden in the learning contexts. That is, physical education, if not positively experienced, might bring negative experiences to the learner. The negative impact may go beyond the physical education setting to compromise their self-initiated motivation for physical activity in leisure times.

Previous studies suggested that students' perception of cost can derive from many pedagogical sources including perceptions of boring curricula, incompetent teachers, physical discomfort, or intimidating peers (Chen & Liu, 2009; Xiang et al., 2006). Although the impact of cost on future participation decisions was found marginal, it can significantly attenuate students' intrinsic value (Chen & Liu, 2009). The findings from this study suggest that cost may exacerbate and further de-motivate students for voluntary physical activity during leisure times.

Motivation for Conceptual Learning

Learning in physical education should be characterized by conceptual learning (Ennis, 2007). This study revealed that the students were able to understand energy-balance concepts by clustering them correctly. However, they demonstrated difficulty in linking these concepts correctly to each other to explain the holistic meaning of energy balance. The inadequate understanding may be attributable to its detachment to expectancy-value constructs. As shown in the results, no expectancy-value constructs except cost significantly led to energy-balance knowledge.

This detachment between expectancy-value motivation and energy-balance knowledge may be explained by the domain specificity of motivation (Bong, 2004). That is, subject to the academic content domains motivation may rely on different contextual

sources and then function differently (Bong, 2004). Expectancy-value motivation constructs were found sharing the domain-specific characteristics in physical education (Shen, McCaughtry, & Martin, 2008). It was found that elementary school students' motivation varied when content changed in physical education (Chen, Martin, Ennis, & Sun, 2008). A scrutiny of the healthful living course in the two high schools revealed that energy-balance knowledge was learned in health classes without incorporating physical activities. This separation between health and physical education was likely to create different learning contexts with distinct domain characteristics from the two content areas. Consequently, expectancy-value motivation was channeled toward physical engagement but not conceptual understanding in physical education.

An unexpected finding is that cost perceived in physical education positively affected concept clusters in the energy-balance knowledge structure. It may be interpreted in two ways. First, the students who understood energy balance better might expect physical education to provide ample energy-expenditure opportunity to balance their energy consumed. But they did not see the current physical education afforded this opportunity. Therefore, they were more likely to perceive the content (playing games) as a cost for achieving their goal to balance energy intake and expenditure. However, this interpretation is yet to be tested in re-structured single directional models. Second, when the students perceived success in physical education to be associated with high cost, they might have invested their effort to constructing energy-balance knowledge. However, this interpretation is inconsistent with the detachment between health and physical education.

Further research is needed to clarify whether knowledge learned in health classes can be bridged sub-consciously with physical education motivation by students.

Conclusion

Taken together, expectancy beliefs and intrinsic value contributed to in-class physical activity; while cost perceptions in physical education undermined after-school physical activity but positively linked to concept-categorizing in the energy-balance knowledge. Other hypothesized paths in the a priori model (Figure 8) were not found statistically significant. The findings point to future research on expectancy-value construct with the domain specificity and contextualized learning orientations.

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CHAPTER V

ENERGY-BALANCE KNOWLEDGE STRUCTURE, PHYSICAL ACTIVITY, AND THE ROLE OF LEARNING CONTEXT

Abstract

With decreased voluntary physical activity among children and adolescents (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008), physical education is considered a critical avenue to provide opportunities for them to increase moderate-to-vigorous physical activity. It is considered equally important to educate them with energy-balance knowledge to help develop and sustain energy-balanced living. Guided by the constructivist perspective on knowledge and behavioral change, this study attempted to determine the way by which ninth graders structured the core concepts of energy balance, and the extent to which the knowledge affected physical activity behavior. A total of 195 ninth grade students studied 16 energy-balance concepts in classroom-based health education classes and participated in daily physical education. Energy-balance knowledge, in-class physical activity and after-school physical activity were measured using concept-mapping, accelerometry, and Three-Day Physical Activity Recall survey. Based on the developed concept-map scoring matrix, it was confirmed that the students held different mental representations about energy balance. The logistic regression analysis indicated that the intuitive and synthetic mental representations had little influence on either in-class or after-school physical activity (β ranges from -.23 to .39, $p > .05$, *Odds ratio*

ranges from .79 to 1.48). The results suggest that the energy-balance concepts learned in sedentary classroom were detached from physical activity behavior experienced in physical education and after school environment. A physical education context that affords students the opportunity to actively construct the energy-balance knowledge with the concepts could bridge the energy-balance knowledge and physical activity behavior.

Introduction

Energy-balanced living behaviors may help address adolescent overweight and obesity (Jansen, Mackenbach, Zwanenburg & Brug, 2010). These behaviors include regular physical activity and healthy eating that collectively help achieve a balance between energy intake and energy expenditure (Dunford, 2010). In school physical education, students are expected to participate in physical activity during classes and to demonstrate sustained participation on their own leisure times (e.g., during after-school hours). With decreased physical activity(Nader, Bradley, Houts, McRitchie, & O'Brien, 2008), it is important to educate K-12 students in physical education to undertake and maintain an energy-balanced lifestyle.

Voluntary behavior and behavioral change are believed to be driven in part by an individual's cognition (von Glaserfeld, 1995). In physical education, essential knowledge acquired via learning experiences could help students make decisions for performance or well-being (Ennis, 2007). The *energy-balance knowledge* refers to an individual's understanding of the balance or imbalance between energy intake and expenditure, the underlying scientific mechanism and useful behavioral regulation for energy balance, and outcomes/consequences of energy imbalance (Dunford, 2010; Katz, 2010). The energy-

balance knowledge is an instructional content included in health education for 9-12 grade schooling and is presented to them in textbooks (e.g., Friedman, Stine, & Whalen, 2009). A critical concern for curriculum theorists and practitioners in physical education is the extent to which students understand the knowledge and its effect on physical activity. The purpose of this study was to determine students' understanding of energy-balance knowledge and its relation to in-class and after-school physical activity.

Knowledge Representation in Mental Models

Knowledge is stored and organized in dynamic and generative conceptual structures that are defined as mental models (Vosniadou, 1994). Learning is a process in which individuals re-structure the existing mental models with learned information. Students' knowledge about physical activity may contain and be organized around misconceptions (Ennis, 2007). For example, middle school boys and girls were found erroneously equating fitness with the appearance of "looking good" and "being thin" rather than being healthy (Placek et al., 2001, p. 316). Misconceptions as such reflected a need for scientifically correct knowledge to be learned to restructure the mental models. This knowledge re-structuring is a process of conceptual change (Vosniadou, 1994).

There are three identified mental models. The *intuitive model* symbolizes one's initial mental representation of knowledge/concepts (Vosniadou, 1994). Subject to prior knowledge and daily experiences, an intuitive mental model is often characterized by misconceptions or erroneous ideas (Alexander, 2006). The *scientific model*, in contrast, represents scientifically correct conceptions (Vosniadou, 1994). For instance, through learning, students could develop a correct mental model about the mechanism underlying

the relationship between energy-intake and weight increase. A *synthetic model* (Vosniadou, 1994), on the other hand, represents partial understanding of an idea or event that is likely a mixture of intuitive and scientific models and represents a transitional conceptual structure. For example, a learner who only knows about one side of the energy balance equation (i.e., either energy intake or energy expenditure) may have a synthetic (partial) mental model of energy balance.

Learning results in conceptual change in that mental model transforms along a continuum from intuitive to scientific. The conceptual change is characterized by three progressive cognitive processes: *accretion, weak restructuring and radical restructuring* (Carey, 1985; Vosniadou, 1994). Accretion refers to inserting new information or knowledge to enrich one's existing conceptual structure (Carey, 1985; Vosniadou, 1994). For example, informing the learner that exercise is an important energy-balance activity for weight control is a form of accretion. However, information accretion does not always reflect higher level of understanding. Weak restructuring is necessary if the newly enriched information is inconsistent with one's current understanding. Weak restructuring enables the learner to adjust the existing conceptual structure to accommodate the new information (Alexander, 2006; Vosniadou, 1994). In weak restructuring, the above learner may need to position and connect the function of exercise with pre-existing knowledge about weight control. The learner may be able to categorize or re-categorize a variety of familiar, daily activities as energy-intake and energy-expenditure behaviors in order to form an enhanced mental model (perhaps a synthetic or scientific model). However, if the reconciliation fails to take place, a radical restructuring may be required.

Radical restructuring revises one's fundamental beliefs so that the new information/conceptions can be accepted (Vosniadou, 1994). For example, when the learner has entrenched the belief that body weight is genetically determined and exercise will not alter it in any way, a radical restructuring is required in order for the learner to understand the function of exercise in relation to weight control.

Physical Activity as a Result of Conceptual Understanding

Moderate-to-vigorous physical activity is often identified as an outcome variable of physical education curriculum and instruction (e.g., Chen, Martin, Sun & Ennis, 2007; McKenzie et al, 2006). Changing students' sedentary behaviors into regular physical activity participation is a major transformation of behavior; it requires radical restructuring of their conceptual structure (Ennis, 2007). A small number of studies have revealed the positive role of knowledge in changing undesirable behaviors, such as physical inactivity, drinking, and smoking.

In a large-scaled survey study, Kenkel (1991) investigated the effect of health-related knowledge on behaviors of smoking, alcohol consumption and exercise after controlling for the years of schooling ($N = 33,630$; Male: $n = 14,177$; Female: $n = 19,453$). Health-related knowledge was measured on three variables: correct responses for whether smoking causes seven illnesses, correct responses for whether heavy drinking causes three illnesses, and correct responses for amount of exercise required to strengthen heart and lungs. Smoking, drinking, and exercise were measured by self-reported responses on the number of cigarettes per day, drinks in the past two weeks and days with five or more drinks in a year, days with five or more drinkers in a year, and minutes of

any exercise in the past two weeks, respectively. The study found that the health-related knowledge positively contributed to the reduction of smoking and alcohol consumption, and the increase of exercising time (e.g., exercise time: $t = 3.64, p < .01$; $t = 4.14, p < .01$, for male and female participants, respectively). Kenkel's (1991) finding demonstrated a positive, direct effect of knowledge on health-related behaviors. It stressed the importance of conceptual knowledge in manipulating behaviors including physical inactivity.

Contento, Koch, Lee, and Calabrese-Barton (2010) intervened in students' energy-balance behaviors. In the study, half of the middle school students ($n = 562$) participated in a 24-lesson-long new science curriculum with focus on energy-balance behaviors and the other half ($n = 574$) participated in a comparison curriculum where energy-balance behaviors were not focused. The new curriculum incorporated motivational strategies to promote obesity risk-reducing behaviors. It was taught by science teachers who received 3-hour-long training prior to the intervention. The study found that the new curriculum significantly increased the stair-climbing behavior for exercise ($F = 18.51, p < .001$). It also reduced consumption of sweetened beverage with meals (Days: $F = 14.84, p < .00$; sizes: $F = 18.91, p < .001$), snacks ($F = 11.45, p = .001$; $F = 6.78, p = .009$) and fast food ($F = 9.65, p = .002$). This study (Contento et al., 2010) supported the importance of cognitive involvement in promoting energy-balance behaviors. However, the study was conducted in science education in which physical activity was not a necessary, instructional component. Energy-expenditure behaviors were less targeted in the intervention than energy-intake behaviors.

In summary, the above two studies demonstrated positive effect of conceptual knowledge on behavior modification. Kenkel (1991) revealed that simply knowing the amount of exercise time required for cardio-respiratory health would lead to the behavior change. Similarly, in Contendo et al.'s (2010) study, cognitively learning the strategies for behavioral change resulted in middle school students' healthier eating behaviors. However, the studies were not conducted in a physical education setting and the findings can hardly be generalized in physical education and after-school physical activity settings. Neither of the two studies focused on how energy-balance knowledge was exposed to and learned by the participants, which limited utility of the findings to inform teaching and learning practice.

Contextual Influence on Conceptual Change and Learning

Learning process has foundation on the ecological situation or context in which the learner interacts with the learning objects (Alexander, Schallert, & Reynolds, 2009). Contextual environment ought to be considered in articulating conceptual change, or schooling in general. Successful learning often relies on a contextualized process where students are afforded with context-relevant facts or new knowledge and understand "when, where, or why they might use them" (Brophy, 2008, p. 136). A coherent, nurturing context or curriculum might need to be present in facilitating conceptual change for the scientific mental models of certain knowledge (Dole & Sinatra, 1998).

In most high schools, the energy-balance knowledge is likely to be learned in classroom settings detached from physical activity. A contextualized process (Brophy, 2008) where students can make direct connection between physical activity and caloric

expenditure is absent in this classroom-centered environment. It is worth knowing whether these detached learning experiences can elicit any positive, weak or radical, conceptual change in students' mental models. Also is it worth knowing whether energy-balance knowledge learned in the classroom can have impact on students' physical activity behavior.

Hence, the study was designed to determine the way by which ninth graders structured the core energy balance concepts learned in health education, and the extent to which the knowledge affected physical activity behavior. The study examined the following two research questions: (a) To what extent could ninth graders correctly construct their mental representations about energy-balance knowledge? and (b) To what extent did their mental representations developed in health education affect physical activity behavior in physical education and after-school hours? Specifically, it was hypothesized that (a) the students would hold mental representations about energy-balance knowledge at various developmental stages; and (b) the scientific mental representations would be associated with high level of physical activity in physical education and after-school time.

Method

Setting and Participants

Two high schools in one large public school district in the southeastern U.S. were selected as the research site. The reasons for choosing these two schools were three-folds. First, the two schools had taught energy-balance knowledge to the students in their healthful living course that fitted the purpose of this research. Second, the physical

educators were proved to be cooperative to assist research efforts that strived to improve their curricula. Third, my previous interaction with the teachers and piloting work further confirmed the two schools as the ideal settings to study essential healthful-living knowledge and behaviors.

Both schools had an enrollment of more than 1,400 students. Approximately 60% of them were ethnic minority students and eligible for free/reduced lunch. Required by the state and the school district, the two high schools implemented a healthful living curriculum that combined physical education and health education. The students were exposed to three grading quarters of physical education classes and one quarter of health education classes. The healthful living classes, either with a focus on physical education or on health education, were taught daily from Monday to Friday. School A had 90 minutes of lesson duration; while School B had 50 minutes.

The lesson lengths were identical for both health education and physical education classes. But the content, instructional format and learning settings (context) were different. The health education content revolved around a textbook required by the state (i.e., Friedman et al., 2009), although teachers might also teach auxiliary content beyond the textbook. At one school, before lecturing, the teacher wrote essential questions for the lesson on the whiteboard for the students to focus on during the lesson. At the other school, the teacher started with a Power Point presentation of information. The energy-balance concepts were major content in a chapter on weight management and eating behaviors (Friedman et al., 2009). Students took notes of the lectures to receive in-class quiz points.

The physical education content consisted of multiple activities or sports; each activity or sport was offered for a period no more than two weeks. At the time of data collection, the students participated in track and field events, ultimate Frisbee, football and pickleball. Both schools established warm-up routines that might include some of the following: callisthenics, running or walking in laps, and flexibility exercises. Following the warm-up routines was the time for competition-based physical activities. Engaging in physical activities and playing for fun were emphasized throughout the class; while knowledge instructions were minimal.

The four teachers, with two from each school, were certified to teach physical education and health. Two held bachelor's degree, two had master's degree in physical education. Their teaching experiences ranged from seven to 28 years. Of the four teachers, three were male and one female. All teachers coached at least one of the following sports at their high school: baseball, cross country, football, soccer, and tennis.

Ninth grade students taught by the four teachers were invited for voluntary participation in the study. Only students whose parents/guardian and who themselves consented for participation were included in the study. The final sample consisted of 195 students (Boys: $n = 80$; Girls: $n = 115$). Data of student ethnicity were not collected due to the school district's policy restrictions. The study was officially approved by the University Institutional Review Board and the school district prior to data collection. The study was supported and cooperated by the four physical educators.

Variables and Measures

Energy-balance knowledge. Energy-balance knowledge was measured using concept-mapping. Concept-mapping is a graphic tool for organizing and representing knowledge, which is used typically in cognitive psychology to measure knowledge structures (Novak, 2005; Novak & Canas, 2008; Novak & Musonda, 1991). A set of concepts were extracted from the health education textbook that the two schools used (Friedman et al., 2009): *Calories, energy balance, energy intake, energy expenditure, food, beverage, obesity, weight increase, weight loss, fat, P.E., physical activity, physical inactivity, metabolism, carbohydrate, and protein*. During the selection a content analysis was conducted to ensure that each concept selected would meet the following criteria: (a) It must be related to energy intake, energy expenditure, physical activity and benefits, or weight management. (b) It must be important as manifested in the textbook using color highlighted definition boxes or other means (e.g., colored, bolded, italic fond, graphic illustration). (c) It must be verified as having been taught to the participating students in formal instruction prior to the study. Informal verification interviews with all the teachers were conducted during the piloting phase (see details in Chapter III). In summary, the 16 core concepts that met the above selection criteria should tap into students' understanding of energy-balance knowledge. The concept-mapping tested students' ability to cluster energy-balance concepts and to identify propositional linkages among concepts. Novak and Musonda (1991) found that the approach of concept-mapping could provide reliable data on knowledge and knowledge structures of participants.

In-class physical activity. In-class physical activity was assessed using accelerometers. The ActiGraph GT3X accelerometer (ActiGraph, Shalimar, FL) is a portable instrument ($1.50 \times 1.46 \times .71$ inches; 0.95 oz) that measures and records physical activity counts in three physical axes. The physical activity counts could be converted to determine activity intensity. Sasaki, John and Freedson (2010) determined the cutoff points for intensity categories (light: count < 1952; moderate: 1953-5724; high: 5725-9498; very high: > 9498). Previous research confirmed that the accelerometer demonstrated high intra-instrument reliability ($r = .86$) and inter-instrument reliability ($r = .86 - .89$) (Melanson & Freedson, 1995).

After-school physical activity. After-school physical activity was measured using the modified *Three-Day Physical Activity Recall* (Weston, et al., 1997). The instrument has been created to measure physical activities in the free-living condition in population-based studies (Pate, Ross, Dowda, Trost, & Sirard, 2003; Weston et al., 1997). The instrument allows participants to recall and record all activities that have occurred between 3:00 and 10:00pm. Respondents fill out 15-minute blocks with any activities that took place during the time period. For each 15-minute block, respondents enter the main activity that occupied most of the 15-minute period. Previous research demonstrated that the instrument had strong evidence for test-retest reliability ($r = .98$) and concurrent validity ($r = .77$ with accelerometers) (McMurray et al., 2004; Weston et al., 1997). Further, extending the physical activity recall period from one day to three days can generate more reliable estimate of after-school physical activity (Trost, 2001).

Data Collection

The data collection was sequenced as (a) concept-mapping, (b) in-class physical activity, and (c) after-school physical activity. The researcher established a set of data collection protocols in advance, and then trained himself by rehearsing and following these procedures during the process of data collection. Parental permissions were received before the data collection started.

Collecting concept-mapping data. The validity and reliability of concept-mapping data rely on participants' understanding of the procedure (Novak & Canas, 2008). A concept-mapping practice was conducted prior to data collection for the students to become familiar with the procedure. The practice session revolved around a set of concepts related to dogs: *Whine, growl, bark, dog sounds, dogs, body parts, tail, paws, ears, fur, run away, scratch, breeds, Beagle, dogs behaviors, Collie, Scottie*. Specifically, with probes and assistance from the researcher, the students performed the following procedures: (a) clustering concepts by spreading them out in an open space; (b) drawing lines or arrows for every identified relation; (c) adding written explanations using relational phrases for each linked relation. At end of these three steps, the students were prompted to revise their concept maps by adding new relevant concepts and exhausting concept relations. Immediately after the practice session, the students were asked to create the concept-map using energy-balance concepts. The students were asked to respond to a focus question: How does energy balance affect our body weight change? They were instructed to apply the same mapping procedures learned from the practice

session to concept-mapping for energy-balance concepts. Questions or confusions from the students were addressed immediately by the researcher.

Collecting accelerometer data. ActiGraph GT3X accelerometers were utilized to collect in-class physical activity data. Prior to data collection, students were taught how to put on the device properly and had the opportunity to wear it for one class session at least one day in advance. This procedure helped the students to get used to the equipment which minimized the effect of reactivity (Heppner, Wampold & Kivlighan, 2008) and improved data reliability. Several hours or the night before data collection, accelerometers were fully re-charged and programmed for the scheduled class periods. The students wore the devices during the entire class time and then returned them to the researcher when the lesson was over. To more accurately reflect students' actual activity level in these two physical education programs, in-class physical activity was assessed in two non-consecutive lessons for each class.

Collecting after-school physical activity data. The after-school physical activity was recalled on two week days and one weekend day that were most adjacent to the time of recall. On the day prior to the recall, the students were instructed to pay attention to types and duration of activities that they would do between 3:00 and 10:00pm of the day. On the next day, pencils and the Three-Day Physical Activity survey were distributed to the students in class for them to fill out by documenting the activity in each 15-minute block. The students were prompted to follow the recall procedures and record the activities as accurate as possible.

Data Reduction

Energy-balance knowledge. The energy-balance knowledge was reduced using a concept-mapping scoring sheet validated by a research panel. The research panel consisted of four researchers who, in previous research, had demonstrated expertise in collecting similar data and validating mental model evaluation rubrics. All had a record of presenting their research on conceptual learning in physical education at AAHPERD and/or AERA conferences. The validated scoring sheet emphasized the correctness of concept clusters and concept propositions as the two key variables for mental representation on a 3-point scale each. A concept cluster is a group of concepts that potentially assumes an intra-class relation. A concept proposition is the specified relation between every two concepts with a labeled explanation. Table 10 illustrates the rubrics of the scoring scale. After two rounds of intensive discussion among the expert panelists, two referent scientific concept maps were established. Appendix D presents the two concept maps. The correctness of concept clusters and propositions shown in the students' concept maps was judged by assessing their deviation from the two referent maps. Following the rubrics, the researcher independently scored the rest of concept maps. A randomly selected 25% of concept maps were scored twice with one day of interval. The Pearson product-moment correlation analysis revealed that the researcher demonstrated high intra-rater reliability ($r = .90$).

Table 10. *The Scoring Rubrics for Concept-Mapping*

Score	Concept Clusters	Concept Propositions
0	Blank or 0 correctly clustered concepts	Blank or 0 correctly connected proposition
1	1-4 correctly clustered concepts	1-4 correctly connected propositions
2	5-8 correctly clustered concepts	5-8 correctly connected propositions
3	9+ correctly clustered concepts	9+ correctly connected propositions

In-class physical activity. In-class physical activity was recorded as vector magnitude counts by minute. To reflect in-class physical activity level, the average counts per minute were computed for each class. As the physical activity was measured for two non-consecutive lesson periods, mean counts per minute for the two measurements were further computed. Next, the intensity of physical activity was converted by following Sasaki et al.'s (2010) categorization (light: count < 1952/minute; moderate: 1953-5724/minute; high: 5725-9498/minute; very high: > 9498/minute). Lastly, to facilitate the Binary Logistic Regression analysis, in-class physical activity level was classified as less active (1) or more active (2), a binary or dichotomous data format. Mean score served as the cut-off point for this classification since it represented the central point of data.

After-school physical activity. After-school activity data were reduced into activity type and duration. The activities recalled by the students were coded into categories of sports, fitness, other physical activity, sedentary academic behaviors, resting, sedentary entertainment, and socializing. The number of filled blocks were counted and converted into duration by multiplying 15 (i.e., 15 minutes per block). In addition, all activities were further coded into physical activity or sedentary activity. Specifically, after-school physical activity consisted of sports, fitness, and other physical activity; while sedentary activity consisted of homework, resting, entertainment, and socializing. As each student recalled activity for two weekdays and one weekend day, the mean after-school physical activity time over the three days was computed to reflect the students' daily physical activity time. Lastly, after-school physical activity time was classified as less active (1) or more active (2), using the mean score of activity time as the cut-off point, to satisfy data analysis.

Data Analysis

First, the students' energy-balance knowledge and physical activity data were analyzed using descriptive analysis. Mean and standard deviation statistics were calculated to reveal the central and dispersion tendencies of the data. Second, to answer the research question - To what extent did ninth graders construct their mental representations about energy-balance knowledge?, low, medium, and high levels of concept maps about energy-balance knowledge were determined by the correctness of concept clusters and concept propositions. The three levels of concept maps were organized into a scoring matrix shown in Table 11. Specifically, the Level-I concept

maps were represented by low scores in concept propositions, low or moderate scores in concept clusters; the Level-III concept maps were represented by high scores in both concept clusters and propositions. The Level-II concept maps were represented by moderate scores in concept propositions, moderate or high scores in concept clusters. Frequency and percentage of mental representations at each level were compiled and concept-map examples were analyzed and presented.

Table 11. *Concept Map Classification*

		<i>Concept Propositions</i>			
		0	1	2	3
Concept Clusters	0	Level-I	Level-I	Level-II	Level-II
	1	Level-I	Level-I	Level-II	Level-II
	2	Level-I	Level-I	Level-II	Level-III
	3	Level-I	Level-II	Level-II	Level-III

Third, the logistic regression was employed to address the second research question: To what extent did their mental representations developed in health education affect physical activity behavior in physical education and after-school hours? In-class physical activity and after-school activity (i.e., overall, sports, fitness, and other) were

specified as the dependent variables; while concept clusters and concept propositions as independent variables. The 95% of confidence interval was set to test the hypothesis ($\alpha = .05$).

Results

Descriptive Results

Table 12 presents the descriptives for energy-balance knowledge, in-class physical activity, and after-school physical activity. The students performed dramatically better on concept clusters than concept propositions. Their average in-class physical activity level was light (light: count < 1952; moderate: 1953-5724; high: 5725-9498; very high: > 9498; Sasaki et al., 2010). The vector magnitude counts per minute ranged from 870 to 4019, which reflected low to moderate intensity of physical activity in physical education. In addition, the students participated in sports, fitness and others physical activities outside of class for approximately 80 minutes, exceeding the recommended 60 minutes per day for adolescents (USDHHS, 2000). Of these active minutes, the students spent more time on sports and other (e.g., housework) than fitness activities.

Mental Representations of Energy-Balance Knowledge

The students demonstrated varied performance on concept mapping. Table 12 presents the frequency and percentage of the concept map scoring characteristics. More than half of the students performed well on concept clusters. In comparison, more than half performed poorly on concept propositions. One third of the students developed Level-I concept maps; while less than one quarter constructed Level-III concept maps.

Table 12. *Descriptive Information of the Variables (N = 195)*

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<i>Variables</i>	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Skewness</i>	<i>Kurtosis</i>
Concept Clusters	2.35	.81	0	3	-1.13	.60
Concept Propositions	1.10	1.16	0	3	.46	-1.32
Accelerometer Data	1890	604	870	4019	.98	.91
3Day Physical Activity Recall	79.03	62.37	0	260	.71	-.05
Sports	31.00	48.17	0	235	1.79	2.73
Fitness	9.08	25.86	0	205	4.78	27.50
Other	38.95	43.59	0	225	1.45	2.01
Sedentary Activity	268.51	113.74	0	420	-1.12	.46
Academic	62.74	46.49	0	290	.89	2.17
Resting	103.26	60.65	0	250	.06	-.51
Entertaining	86.74	66.71	0	310	.88	.68
Socializing	15.77	25.86	0	145	2.00	4.50
Unreported Minutes	9.08	25.86	0	205	4.78	27.50

Table 13. Distribution of Low, Medium and High Performers on Concept-Mapping

Score	Concept Clusters (N/%)	Concept Propositions (N/%)	Concept Maps (N/%)
1	25/13%	106/54%	65/33%
2	56/29%	60/31%	84/43%
3	114/58%	29/15%	46/24%
Total	195/100%	195/100%	195/100%

Figure 14, Figure 15, and Figure 16 illustrate three concept-map examples that represented Level-III, Level-II, and Level-I concept maps. Figure 14 reflected a Level-III concept map about energy-balance because the student not only correctly clustered more than nine concepts, but also appropriately described more than nine propositional links among concepts. The student was fully aware that energy intake and energy expenditure were the two ingredients of energy balance with each nesting other relevant concepts.

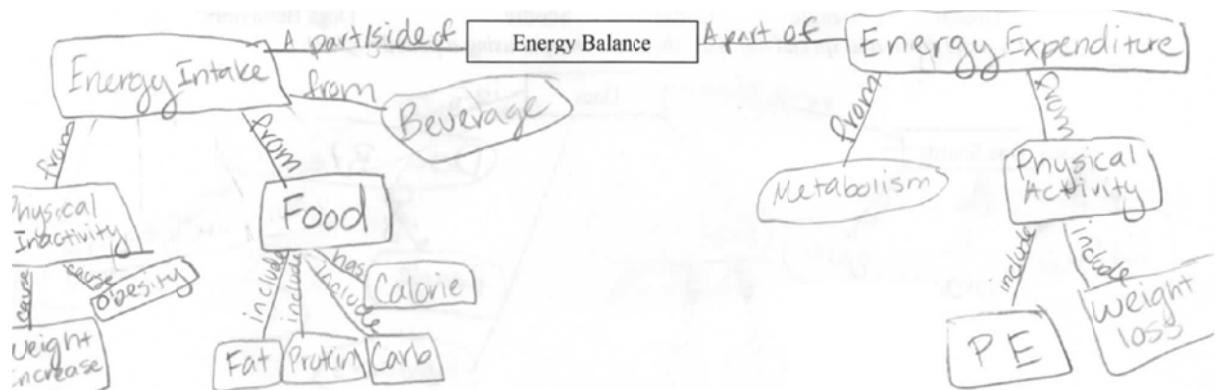


Figure 14. A Level-III Concept Map about Energy-Balanced Knowledge

Figure 15 presents a Level-II concept map about energy balance. The concept map shows that the student correctly clustered nine concepts (i.e., energy intake, protein, beverage, food, fat, energy expenditure, P.E., physical activity and weight loss), but failed to describe any propositions among the concepts. The lines among concepts indicate the student's attempts to identify concept propositions. However, without written explanations attached, the lines were at best symbols that helped reiterate concept clusters, rather than propositional linkages. In addition, this concept map also included inappropriate or irrelevant clusters. Hence, it was inferred that the student seemed to have a certain degree of understanding about energy-balanced living, but might also have confusions or inadequate relational knowledge about it. Clearly, the student still had much room for improvement in order to achieve the scientific mental models.

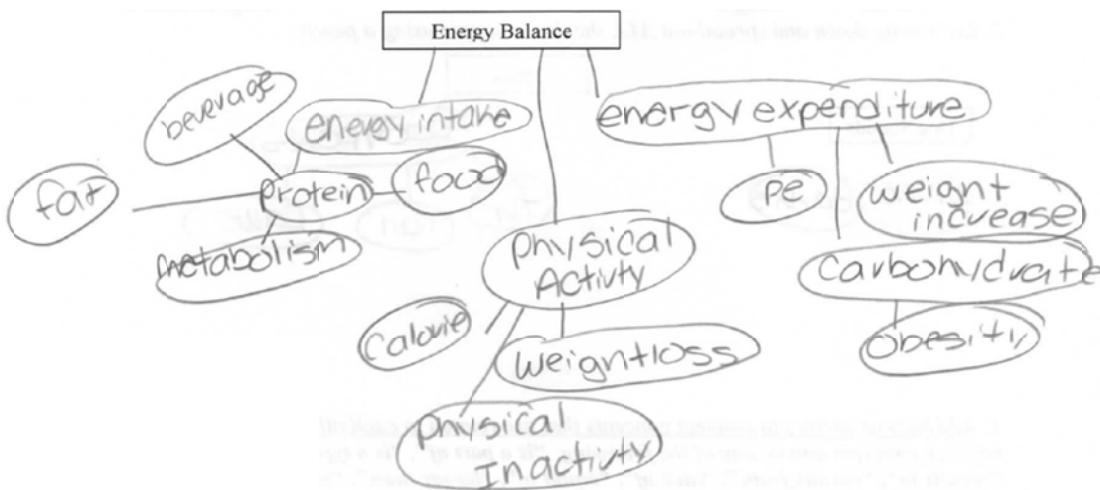


Figure 15. A Level-II Concept Map about Energy-Balance Knowledge

Figure 16 presents a Level-I concept map about energy-balance knowledge. The concept map had less than four correctly clustered concepts (i.e., energy expenditure, energy intake). The rest of concepts did not show clear patterns of being clustered. In addition, not all concepts were propositionally linked together and none written descriptions were marked to specify the linkages. Presumably, the concept map shows that the student might have known some of the energy-balance concepts as random, discreet knowledge facts. Energy-balance knowledge went beyond the students' current level of cognitive understanding.

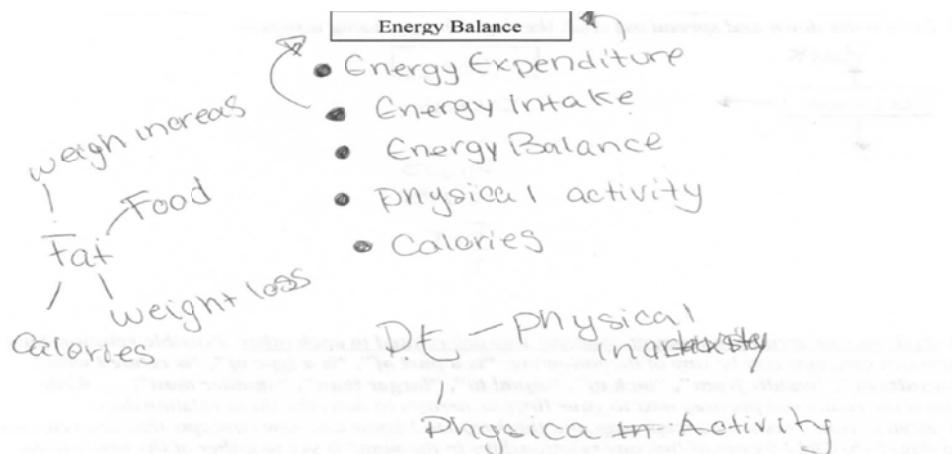


Figure 16. A Level-I Concept Map about Energy-Balanced Knowledge

Logistic Regression Results

The logistic regression analysis was conducted to test the extent to which energy-balance knowledge affected in-class and after-school physical activity. Shown in Table 14, concept clusters and concept propositions did not significantly predict in-class or after-school physical activity (β ranges from -.23 to .39, $p > .05$, Odds ratio ranges

Table 14. *Logistic Regression Results*

	β	SE	Wald	df	p	OR
In-Class Physical Activity Level						
Concept Clusters	-.01	.21	.00	1	.52	.99
Concept Propositions	-.04	.15	.06	1	.62	.97
After-School Physical Activity Time						
Concept Clusters	-.05	.20	.06	1	.81	.95
Concept Propositions	-.16	.14	1.25	1	.26	.95
After-School Sports Time						
Concept Clusters	.39	.24	2.69	1	.10	1.48
Concept Propositions	-.23	.16	2.20	1	.14	.79
After-School Fitness Time						
Concept Clusters	.35	.28	1.58	1	.21	1.43
Concept Propositions	.15	.17	.81	1	.37	1.17
Other After-School Activity Time						
Concept Clusters	-.04	.21	.04	1	.85	.96
Concept Propositions	.15	.15	1.05	1	.31	1.16

Note. OR = odds ratio

from .79 to 1.48). The odds ratios were too marginal to have substantive meaning. That is, different mental representations had similar or identical chance to influence students' in-class and after-school physical activity behaviors. In other words, the results suggest that there is a disconnection between the maturity of mental representations and physical activity participation.

Discussion

This study examined the extent to which ninth graders correctly constructed energy-balance knowledge and the extent to which this knowledge affected physical activity in physical education and after-school hours. The results confirmed that the students held different mental representations about energy balance and that the mental representations had equal chance to influence in-class and after-school physical activity. The two salient findings are (a) after health education classes, most students did not correctly construct the mental representations ; (b) consequently, their mental representations were not able to guide their physical activity behavior in both physical education and after school hours. These findings may point to the likelihood that the energy-balance knowledge learned in a de-contextualized health education classroom has limited implication for behavioral change.

Mental Representations about Energy-Balance Knowledge

The data seem to show that the students overall were able to construct synthetic mental representations based on the knowledge they learned in health education. However, concept-clustering appeared to be an easier task than identifying propositional linkages among concepts. The number of students who performed well on concept clusters was nearly four times as those who performed well on concept propositions. Conversely, the ratio of low performance on concept propositions was over four times higher than low concept clusters. These characteristics reflected a weak relational understanding among the concepts.

Relational understanding anchors intertwined relations among concepts. It is representation of a more complex knowledge structure that cannot be acquired in isolated learning environment where information is learned in a piecemealed fashion (Ennis, 2007). Although both concept clusters and concept propositions represent relational understanding (Novak, 2005; Novak & Canas, 2008; Novak & Musonda, 1991), concept proposition is the indicator for high-order relational understanding. Many students in this study failed to demonstrate the ability to construct their concept map at a level of this high-order relational understanding. The above finding indicates that the students were in need of developing the complex relational knowledge about energy balance for healthful living.

Vosniadou (1994) argued that along the path in learning certain knowledge, mental model transformation from intuitive to scientific is a gradual process. The evidence of this study may confirm this assertion. The data demonstrated that the ninth graders' mental representations of energy-balance were at different developmental stages. Of all, the mental representations at the Level-I synthetic level, held by one-third of the students, should be a concern for us. The Level-I mental representations imply that despite formal instruction about the essential knowledge, little was retained in some students' conceptual structure. Ennis (2001) and Placek et al. (2001) have argued that naïve or misconceptions about healthful-living knowledge are not uncommon among secondary school students.

In addition, a sizeable number of the students held Level-II synthetic mental representations. Synthetic models are a necessary stage in transitioning intuitive models

toward scientific models (Vosniadou, 1994). These students seemed to be cognizant of the concepts related to energy balance but only understood the basic relations among these concepts. As ninth grade usually is the last year for mandatory physical education and health education, this finding cautions curriculum designers and physical educators to design and implement strategies to help students advance synthetic models into scientific models. Needless to say, scientific mental models are difficult to achieve. In this study, only about one quarter of the students demonstrated their knowledge structure at the Level-III synthetic stage. This finding challenges us to find innovative instructional strategies to enhance the way students to construct their knowledge in our classes.

From a practical viewpoint, this finding points out the need to focus on relational understanding in teaching and learning the energy-balance knowledge. To develop scientific mental models about energy balance successfully, the curriculum and instruction should go beyond simply conveying factual information to students. In learners' conceptual structures, the newly acquired information needs to reconcile with existing knowledge so that misconceptions or naïve conceptions will be replaced in the process of either weak or radical restructuring (Ennis, 2007; Vosniadou, 1994). During this process, it seems critical for us to nurture students' ability to identify propositional linkages among essential concepts.

Physical Activity and De-Contextualized Knowledge

Another finding of this study is that the constructed energy-balance knowledge was inadequate to guide students' physical activity behavior. The logistic regression analysis failed to identify greater odds for scientific mental representations to impact in-

class and after-school physical activity participation. That is, the odds for enhancing in-class and/or after-school physical activity remained statistically identical for all students, regardless of their level of understanding about energy balance.

The foundation for learning is the systemic, dynamic, and interactive relations between the learner and the learning content in an ecological context (Alexander et al., 2009). The role of a coherent educational context is extremely important to facilitate student learning (Beane, 1995; Ennis, 2008). The perspective of contextualized learning is relevant for understanding the detachment between mental models and physical activity found in this study. The ninth grade students from the two high schools experienced health education and physical education separately. The health knowledge and principles (e.g., energy-balance knowledge) relevant to the students' physical activity experiences were taught in health classes without incorporating actual physical activities. Similarly, physical activities (e.g., sports, games, fitness activities) were experienced in physical education classes with little guidance from health-related scientific knowledge learned in health classes. Health education and physical education functioned separately with independent educational purposes, format, and assessment. Consequently, the students were unable to develop the concept-behavior linkage necessary to guide their behavioral decisions in physical education and during after-school hours.

The separate educational environments might have compromised the opportunity when the students constructed energy-balance knowledge and its relation to physical activity. von Glaserfeld (1995) argued that voluntary behavior or behavioral change is guided by deeply processed cognition. The energy-balance knowledge acquired from

health classes might be perceived as remote information to energy-expenditure behaviors in physical education classes or during after-school leisure times. Hence, the two disconnected learning contexts could undermine learners' deep processing of information about energy balance, especially in relation to physical activity.

The ideal learning context to construct health knowledge related to exercise needs to incorporate moderate physical activity (Chen & Chen, 2010). Simply transmitting the energy-balance knowledge from the teacher to students in a health class without physical activity experience may constrain students from constructing meanings relevant for both knowledge and behavior. It may also compromise the learning process for students to understand "when, where, or why they might use" the new knowledge (Brophy, 2008, p. 136). Thus, the energy-balance knowledge, as a content relevant to physical activity (an energy-expenditure behavior), should be learned in a physically active context so that the students could authentically and deeply understand the knowledge and its function in relation to physical activity.

In conclusion, this study has provided a snapshot about students' energy-balance knowledge in relation to physical activity behaviors. Energy-balance knowledge was not found to be a guiding force for physical activity behaviors in the ninth grade student sample. The intuitive and synthetic mental models constructed in health classes were inadequate in guiding physical activity behavior. The findings suggest that separation of the related content in detached contexts might have prevented the students from developing deep, relational understanding about the energy-balance knowledge and its relation to physical activity. A contextualized learning environment should be created in

physical education with moderate-to-vigorous physical activity to bridge mental models with behaviors.

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CHAPTER VI

CONCLUSIONS AND IMPLICATIONS

Conclusions

This dissertation research was intended to answer three research questions: (a) To what extent did expectancy-value constructs affect energy-balance knowledge, in-class and after-school physical activity? (b) To what extent did ninth graders correctly construct their mental representations about energy-balance knowledge? And (c) To what extent did their mental representations developed in health education affect physical activity behavior in physical education and after-school hours? Major findings that answered these research questions include the following.

1. Expectancy beliefs and intrinsic value positively facilitated the students' in-class physical activity; cost perceived in physical education undermined students' physical activity participation during after-school hours. However, cost unexpectedly linked positively to concept clusters in energy-balance knowledge structure.
2. The students held categorically different mental representations about energy-balance knowledge, ranging from Level-I to Level-III synthetic. Most mental representations demonstrated the Level-I and Level-II synthetic characteristics.
3. Energy-balance knowledge was detached from physical activity in physical education and during after school hours.

Collectively, the findings indicate that (a) the role of expectancy-value motivation is complex when the cost construct is taken into account. The components of the

expectancy-value construct functioned differently toward different outcome measures. (b) The students may learn the energy-balance knowledge from the same sources but are likely to construct the knowledge differently in their conceptual structures. Most of the conceptual structures can be premature. (c) Energy-balance knowledge learned in health classes without experiencing physical activity is likely to detach from physical activity behavior in physical education and leisure times. The de-contextualized learning experience may prevent the knowledge from guiding students' physical activity behavioral change needed for developing and sustaining an energy-balanced living.

Theoretical Implications

The research findings from this dissertation research have significant theoretical implications to physical education research. First, expectancy beliefs for success and intrinsic value positively contributed to the students' in-class physical activity only. The finding indicates that physical education students are likely to commit their motivation to physical activity rather than to cognitive learning in a multi-activity curriculum. To nurture the "sound mind in a sound body" (Ennis, 2007), future research is needed to determined specific motivation function of each component in the expectancy-value construct.

Second, cost perceptions, on the other hand, negatively impacted the students' after-school physical activity but positively linked to concept clusters. These findings exposed the strength and limitations of expectancy-value constructs as applied in physical education. In addition, the unexpected positive role of cost as associated with concept

clusters may suggest a new way to articulate the expectancy-value motivation theory in which the trade-off between values and cost needs to be explored by taking into account the domain specificity theory.

Third, the detachment between energy-balance knowledge and physical activity signifies the importance of learning contexts to knowledge-guided physical activity participation. Our findings demonstrated that the students were not able to direct their physical activity, both in physical education and after school, according to their energy-balance knowledge. It is clear that the constructivist learning theory needs to be incorporated in future intervention studies to bridge the gap between knowledge learned in health education and its application in physical activity.

Practical Implications

The research findings from the studies can inform the practice of teaching and learning in physical education. First, in promoting adolescents' in-class physical activity participation, the educators should create an educational environment that nurtures learners' beliefs in attaining success and intrinsic value. The nurturing should be based on an effort to develop learners' judgment about their competence and control in the learning process (Zimmerman & Schunk, 2006). The expectancy beliefs for success are often influenced by a variety of contextual, instructional, and task characteristics. For example, an interesting but challenging task delivered by a caring teacher who empowers his/her students certain choice or autonomy (e.g., selection of equipments) shall nurture and strengthen the expectancy beliefs.

Second, to facilitate after-school voluntary physical activity, physical educators should not underestimate the negative effect of cost perceived by students in physical education. These negative perceptions may carry over and jeopardize adolescents' leisure-time physical activity behaviors. Instead, physical educators should minimize the cost that may be manifested physically (e.g., fatigue), cognitively (e.g., little problem-solving involved) and socially (e.g., relying on excessive negative feedback).

Third, the findings pertaining to the relationship among motivation, knowledge of energy balance, and physical activity imply that cognitive learning seems to be detached from physical activity experiences. Conceptual knowledge is often acquired in separation from the behavior it is supposed to guide. This separation not only seems unnecessary, but also creates an incoherent learning context where the learners are unable to make meaningful connections between knowledge and behavior. Hence, it is recommended that physical educators should strive to create a meaningful learning context for students to intentionally bridge the learned, conceptual knowledge with physical activities.

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124th American Alliance for Health, Physical Education, Recreation and Dance
national convention. Tampa, Florida.

APPENDIX A
OFFICIAL APPROVAL LETTER FROM GCS



February 24, 2011

Senlin Chen
506G Warren Street
Greensboro, NC 27403

Re: 101126

Dear Senlin Chen:

The Guilford County Schools Research Review Committee has concluded that your proposal *Ninth Graders' Expectancy-Value Motivation, Knowledge of Energy Balance and Physical Activity* meets the requirements of state legislation and the current research policy of the Guilford County Schools.

Committee approval does not guarantee access to schools or to individuals, nor does it imply that a study can or will be conducted. School principals have the final decision regarding the participation of the school in any research project. In addition, teachers, parents, and students decide individually whether they wish to participate. Finally, the committee expects that identities of individuals and schools will be confidential at all stages of the project.

Please present this letter upon initial contact with principals. We hope that the project is successful in helping to achieve your goals. Please feel free to contact me at 336-370-2346 if you have any questions.

Sincerely,

Carolyn Gilbert
Co-Chair, Research Review Committee

APPENDIX B

IRB APPROVED LETTER, CONSENT AND ASSENT FORMS



THE UNIVERSITY of NORTH CAROLINA
GREENSBORO

OFFICE OF RESEARCH COMPLIANCE
2718 Beverly Cooper Moore and Irene Mitchell Moore
Humanities and Research Administration Bldg.
PO Box 26170
Greensboro, NC 27402-6170
336.256.1482
Web site: www.uncg.edu/orc
Federalwide Assurance (FWA) #216

To: Ang Chen
Dept of Kinesiology
250 HHP Building

From: UNCG IRB


Authorized signature on behalf of IRB

Approval Date: 3/14/2011

Expiration Date of Approval: 3/12/2012

RE: Notice of IRB Approval by Expedited Review (under 45 CFR 46.110)

Submission Type: Initial

Expedited Category: 7.Surveys/interviews/focus groups,4.Noninvasive clinical data

Study #: 11-0120 **Study Title:** Ninth Graders' Expectancy-Value Motivation, Knowledge of Energy Balance and Physical Activity

This submission has been approved by the IRB for the period indicated. It has been determined that the risk involved in this research is no more than minimal.

Study Description:

The purpose of this research is to identify the extent to which adolescents' expectancy-value motivation, mastery of energy balance concept, and physical activity behavior interact with each other in light of the obesity epidemic.

Regulatory and other findings:

This research, which involves children, meets criteria at 45 CFR 46.404 (research involving no greater than minimal risk).
Permission of one parent or guardian is sufficient.

Investigator's Responsibilities

Federal regulations require that all research be reviewed at least annually. It is the Principal Investigator's responsibility to submit for renewal and obtain approval before the expiration date. You may not continue any research activity beyond the expiration date without IRB approval. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.

When applicable, enclosed are stamped copies of approved consent documents and other recruitment materials. You must copy the stamped consent forms for use with subjects unless you have approval to do otherwise.

You are required to obtain IRB approval for any changes to any aspect of this study before they can be implemented (use the modification application available at <http://www.uncg.edu/orc/irb.htm>). Should any adverse event or unanticipated problem involving risks to subjects or others occur it must be reported immediately to the IRB using the "Unanticipated Problem/Event" form at the same website.

CC:Senlin Chen, Dept Of Kinesiology, Chris Farrior, (ORED), Non-IRB Review Contact, (ORC), Non-IRB Review Contact

UNIVERSITY OF NORTH CAROLINA AT GREENSBORO

CONSENT FOR A MINOR TO ACT AS A HUMAN PARTICIPANT: LONG FORM

Project Title: NINTH GRADERS' EXPECTANCY-VALUE MOTIVATION, KNOWLEDGE OF ENERGY BALANCE AND PHYSICAL ACTIVITY

Principle Investigator: Dr. Ang Chen

Project Director: Mr. Senlin Chen

Participant's Name: _____

What is the study about?

The purpose of this study is to assess how much ninth grade students know about energy balance, and how this knowledge relates to his/her motivation in physical education and physical activity behaviors.

Why are you asking my child?

As a ninth grade student, your child and all his/her classmates taught by the identified teachers are invited for participation.

What will you ask my child to do if I agree to let him or her be in the study?

As a participant, your child will be asked to respond to two short surveys, participate in one concept-mapping task, and wear accelerometers to contribute data. The *accelerometer* is a device about size of a pager to be worn by your child with an elastic waist belt to record caloric expenditure. During the class time, approximately 10 minutes will be allocated for responding to one survey, 25 minutes for doing concept-mapping, and 5 minutes for wearing/removing accelerometers. In addition, approximately 30 minutes of after school time is required to recall physical activity. No stress, pain (physical, psychological, or emotional), or any other unpleasant reaction will be caused by any of these procedures.

What are the dangers to my child?

The Institutional Review Board at the University of North Carolina at Greensboro has determined that participation in this study poses minimal risk to participants. The research imposes no known physical and psychological risks to participants. Your child's decision to participate will not affect his/her grades or standing at the school. If you have any concerns about your child's rights, how they are being treated or if you have questions, want more information or have suggestions, please contact Eric Allen in the Office of Research Compliance at UNCG at (336) 256-1482. Questions about this project or benefits or risks associated with being in this study can be answered by Dr. Ang Chen or Senlin Chen who may be contacted at (336)256-8556 (or email: s_chen3@uncg.edu/a_chen@uncg.edu).

Are there any benefits to my child as a result of participation in this research study?

There are no direct benefits for participating in this research study.

Are there any benefits to society as a result of my child taking part in this research?

Implications of the findings pertinent to motivational and instructional strategies for learning and behavioral change may be synthesized and shared with participating teachers, the Guilford County Schools (GCS), and researchers/practitioners in physical education and education. This may provide useful suggestions for GCS and other school districts to make

UNCG IRB
Approved Consent Form

Valid 3/4/11 to 3/12/12

important decisions for curriculum and instruction reform or regulations to the course of Healthful Living.

Will my child get paid for being in the study? Will it cost me anything for my kid to be in this study?

There are no costs to you or payments to you or your child as a result of participation in this study.

How will my child's information be kept confidential?

All information obtained in this study is strictly confidential unless disclosure is required by law. Identification numbers, rather than personal information, will be assigned to each student participant and used throughout the research to protect privacy. All collected data will be stored in a locked file cabinet in the Pedagogical Kinesiology Laboratory at the University. And the electronic data will be kept in a password protected data computer on campus with access only to the researcher.

What if my child wants to leave the study or I want him/her to leave the study?

You have the right to refuse to allow your child to participate or to withdraw him or her at any time, without penalty. If your child does withdraw, it will not affect you or your child in any way. If you or your child chooses to withdraw, you may request that any data which has been collected be destroyed unless it is in a de-identifiable state."

What about new information/changes in the study?

If significant new information relating to the study becomes available which may relate to your willingness allow your child to continue to participate, this information will be provided to you.

Voluntary Consent by Participant:

By signing this consent form, you are agreeing that you have read it or it has been read to you, you fully understand the contents of this document and consent to your child taking part in this study. All of your questions concerning this study have been answered. By signing this form, you are agreeing that you are the legal parent or guardian of the child who wishes to participate in this study described to you by Mr. Senlin Chen.

Participant's Parent/Legal Guardian's Signature _____ Date: _____

UNCG IRB
Approved Consent Form

Valid 3/14/11 to 3/2/12

**UNIVERSITY OF NORTH CAROLINA AT GREENSBORO
ASSENT FORM TO ACT AS A HUMAN PARTICIPANT**

Study Title: NINTH GRADERS' EXPECTANCY-VALUE MOTIVATION, KNOWLEDGE OF ENERGY BALANCE AND PHYSICAL ACTIVITY

My name is Mr. Senlin Chen.

What is this about?

I would like to talk to you about your expectancy-value motivation, knowledge of energy balance, and physical activity behavior. I want to learn about your motivation in physical education, your knowledge, and your physical activity.

Did my parents say it was ok?

Your parent(s) said it was ok for you to be in this study and have signed a form like this one.
Why me?

We would like you to take part because you are one of those ninth grade students who know about energy balance. All your classmates have been invited to participate in the project.

What if I want to stop?

You do not have to say "yes", if you do not want to take part. We will not punish you if you say "no". It will not affect your grades or standing at the school. Even if you say "yes" now and change your mind after you start doing this study, you can stop and no one will be mad at you.

What will I have to do?

As a participant, you will be asked to respond to two surveys and participate in one concept-mapping task during two classes and three after-school periods, and wear accelerometers during one class to contribute data. The accelerometer is a device about size of a pager to be worn on an elastic waist belt to record how many calories you lose while you are doing physical activities.

Will anything bad happen to me?

There is nothing bad that will happen to you.

Will anything good happen to me?

You will have the opportunities to think about your knowledge about energy balance and its implications. It may benefit you to use essential knowledge in making healthful behavioral decisions.

Do I get anything for being in this study?

No incentives will be given to you directly. However, your Healthful Living program may be given some pedometers that you might use in the future.

What if I have questions?

You are free to ask questions at any time.

If you understand this study and want to be in it, please write your name below.

Signature of child

Date

Page 1 of 2

Version 7/15/10

UNCG IRB
Approved Consent Form

Valid 3/14/11 to 3/12/12

APPENDIX C

DATA COLLECTION WORKSHEET FOR CONCEPT-MAPPING

Concept-Mapping Worksheet

Name: _____ Block: _____ PE/Health Teacher: _____

❖ Part I: Concept-Mapping Practice

1. *Below are some dog concepts. Think carefully about the relationships among these concepts.*

Whine	Growl	Bark	Dog Sounds	Dogs	Tail
Body Parts	Paws	Ears	Run Away	Fur	Scratch
Breeds	Beagle	Behaviors	Collie	Scottie	Dogs

2. *Let's write down and spread out ALL the dog concepts using a pencil:*

3. *Add lines or arrows to connect concepts that are related to each other. Possible relationships between concepts can be any of the following: "is a part of", "is a type of", "is related with", "results in", "results from", "lack of", "equal to", "larger than", "smaller than", Write down the relational phrases next to your lines or arrows to describe these relationships.*

4. *Review your finished concept map and think (a) Do I know any new concepts that are relevant to dogs? (b) Did I forget to link any relationships in the map? If yes to either of the two, please add them on the map.*

❖ Part II: Concept-Mapping for Energy Balance Concepts

- What is energy balance?
- Explain how to lose or increase body weight?
- What are the usual ways to take energy into your body?
- What are the usual ways to expend energy?

1. *Now let's see how much you know about energy balance. Below are some concepts related to energy balance. Think carefully about the relationships among these concepts.*

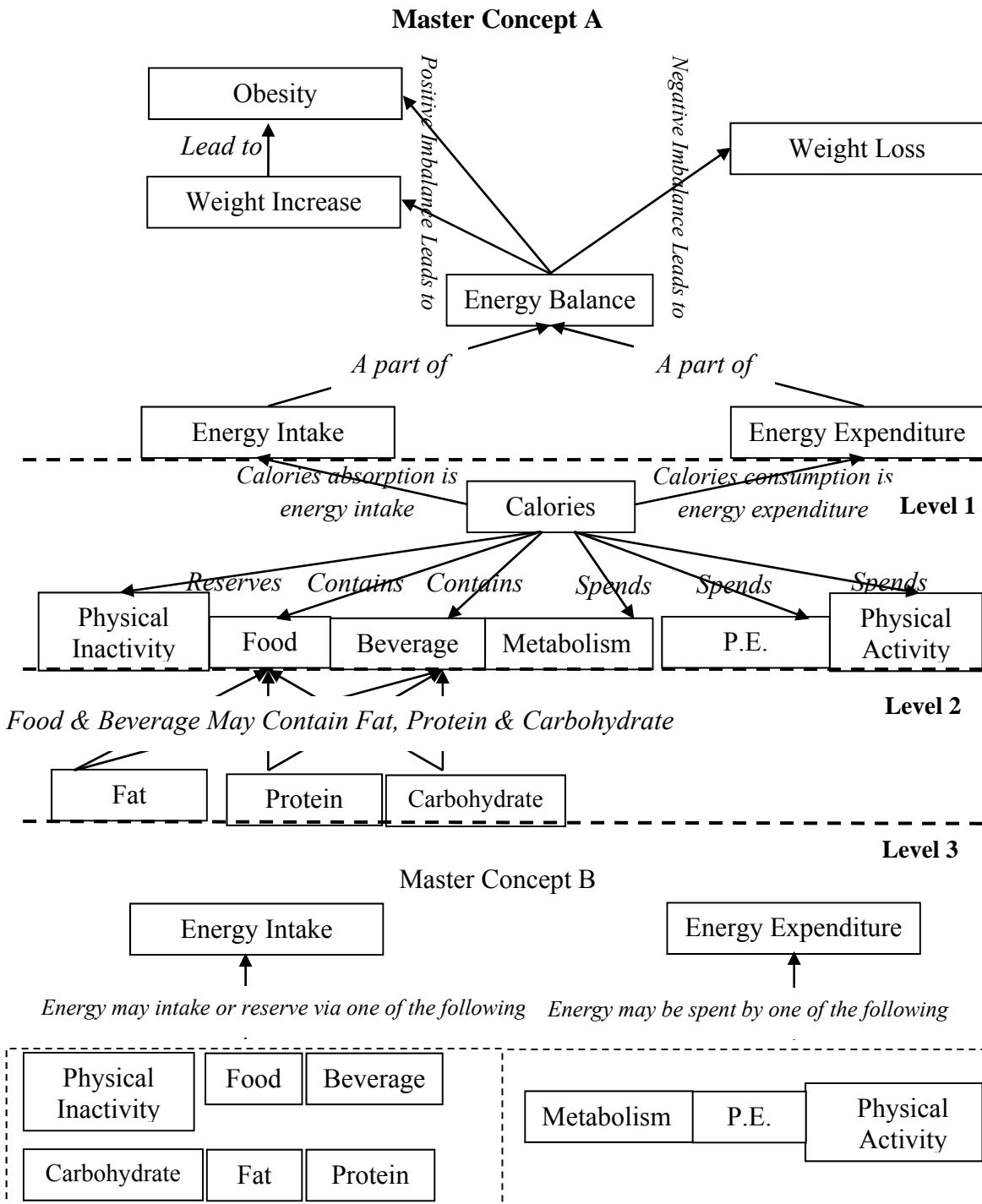
Energy Balance	Energy Intake	Energy Expenditure	Food
Beverage	Obesity	Weight increase	Weight Loss
Fat	P.E.	Physical Activity	Metabolism
Carbohydrate	Protein	Physical Inactivity	Calorie

2. *Next, I want you to do concept mapping for these concepts by thinking about the question: How is energy balance useful to our body weight change? Write down and spread out ALL the concepts using a pencil.*

3. *Add lines or arrows to connect concepts that are related to each other. Possible relationships between concepts can be any of the following: "is a part of", "is a type of", "is related with", "results in", "results from", "lack of", "equal to", "larger than", "smaller than", Write down the relational phrases next to your lines or arrows to describe these relationships.*

4. *Review your finished concept map and think (a) Do I know any new concepts that are relevant to energy balance? (b) Did I forget to link any relationships in the map? If yes to either of the two, please add them on the map.*

APPENDIX D
RELATIVELY SCIENTIFIC CONCEPT MAPS



APPENDIX E
AFTER-SCHOOL PHYSICAL ACTIVITY CODES

<i>After-School Activity Codes</i>									
Old Code	New Code	Activity	Old Code	New Code	Activity	Old Code	New Code	Activity	
1	1	Basketball	22	2	Exercise	43	4	Drawing	
2	3	Dance	23	3	Skateboarding	44	7	Church	
3	2	Bike	24	5	Napping	45	1	Karate	
4	1	Football	25	3	Throwing/catching	46	1	Baseball/softball	
5	4	Reading	26	2	Walking	47	2	Stretching	
6	2	Running	27	1	Volleyball	48	2	Sit-up	
7	6	Watching TV	28	3	Shopping	49	2	Fitness	
8	5	Eating	29	3	Kickball	50	1	Ping pong	
9	5	Sleeping	30	2	Climbing	51	3	Trampoline	
10	4	On bus	31	2	Pushup	52	5	Cooking	
11	4	Homework	32	4	Music instrument	53	1	Hockey	
12	6	Listen to the music	33	3	Soccer	54	7	Horse riding	
13	7	Scooter	34	1	Badminton	55	6	Magic smart youth	
14	7	Phone	35	1	Tennis	56	6	Baby-sitting	
15	6	Games	36	6	Taps	57	1	Lacrosse	
16	5	Shower	37	6	Wall ball	58	1	Golf	
17	7	Chatting/family time	38	1	Tae Kwon Do	59	4	Drama practice	
18	1	Gymnastics	39	1	Swimming	60	7	Hanging out with friends	
19	6	Playing cards	40	3	Chore/year work	61	4	Choir	
20	2	Jumping rope	41	6	Video game	62	7	After-school activity	
21	6	Computer	42	6	Party	63	6	Circus	
						64	2	Step	

Note: 1 = Sport; 2 = Fitness; 3 = Other Physical Activity; 4 = Sedentary – Academic;

5 = Rest; 6 = Sedentary – Entertainment; 7 = Sedentary – Socializing