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Original Article

Evaluation of a concept-based physical education unit for energy balance education

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Abstract

Background: Physical education (PE) is a key channel that impacts children's decisions and behaviors for healthful living. This study evaluated the effects of a concept-based PE (CBPE) instructional unit, featured by energy balance (EB) education, on students' knowledge learning, situational interest, cognitive and physical engagements as well as teachers' perceptions.

Methods: Fourth and 5th grade students ($N = 468$) in a mid-western state of the United States were recruited as the participants. Four elementary schools were randomized to the CBPE or control groups. Students' EB knowledge, situational interest, cognitive engagement, and physical engagement were measured by a knowledge test, the Situational Interest Scale—Elementary, written task sheets, and accelerometers, respectively, while teachers' perceptions of the CBPE unit were captured by individual interviews at the end of the experiment.

Results: The CBPE group showed a significant increase in EB knowledge, while the control did not. Both groups showed a similar increasing trend for situational interest over time, although the statistical results favored the control group. For physical engagement, the CBPE group demonstrated a statistically different but substantively similar level of in-class physical activity compared to the control group. The CBPE group also showed a moderate level of cognitive engagement throughout the unit. The PE teachers reported overall positive perceptions about teaching the CBPE unit.

Conclusion: These results support the utility of the CBPE unit in enhancing EB education along with facilitating positive student interest and engagement as well as positive teaching experiences.

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Keywords: Curriculum intervention; Constructivist learning theories; Cognitive engagement; Energy balance knowledge; Evaluation; Physical engagement; Situational interest

1. Introduction

Schools provide an important setting to promote physical activity (PA) and healthy eating among youth.^{1,2} In physical education (PE), most school-aged youth have the opportunity to learn the essential knowledge, skills, and behaviors needed for living an active and healthy life.³ Coherent PE curricula offer systematic learning experience for students to learn *knowledge of most worth*.^{3,4} With the shrinking instructional time,⁵ offering purposeful PE curriculum and instruction to prepare students for lifetime PA participation is challenging but necessary. In

light of the overweight and obesity epidemic,⁶ knowledge about energy balance (EB knowledge) appears to be an essential content for students to learn, comprehend, and apply in and outside of PE.^{7,8} EB refers to the balance between energy intake and energy expenditure, which largely regulates the fluctuation of body weight.^{9,10} EB knowledge pertains to the concepts, principles, and strategies related to EB or imbalance as well as its behavioral outcomes.^{7,8}

Previous research has shown that having a sound knowledge base about EB is positively associated with health-related behaviors such as increased PA and reduced consumption of sweetened beverages.^{11,12} Furthermore, learning EB knowledge in PE classes is feasible, and exploratory work has been conducted to promote EB in PE.^{13,14} However, these early works (i.e., using 2 EB lessons) only demonstrated marginal effects on

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knowledge increase, suggesting the need for adding more PE lessons to increase the curriculum intervention magnitude. Informed by the constructivist learning theories^{15,16} and the exploratory research evidence,^{13,14} we evaluated the utility of an 11-lesson concept-based PE (CBPE) instructional unit.

Learning takes place when a person thinks, reasons, believes, and processes information, in part, by expanding or altering the individual's existing knowledge base.¹⁷ According to the social constructivist learning theory, students build new knowledge on the foundation of the existing knowledge to close the knowledge gap between self and the more capable peer (i.e., zone of proximal development).¹⁶ A constructivist curriculum uses learning tasks that provide activation cues (e.g., through questioning and problem-solving on written tasks) demanding active cognitive engagement and learner commitment.^{18,19} Cognitive engagement refers to the extent to which students attend and expend mental effort in the learning tasks encountered.¹⁹ The level of cognitive engagement and learner commitment are reflected by the extent to which a student interacts with the learning task, process, and context, with the goal of constructing enhanced understanding of knowledge.²⁰ Applying it to a PE setting, a constructivist curriculum offers coherent curricular experiences that bridge the students' mental engagement with kinesthetic experiences, which is often viewed personally meaningful by the students.³

CBPE is a social constructivist curriculum from which students learn important concepts related to healthful-living through active movements in PE. A previous CBPE curriculum, the *Science, PE, and Me* curriculum, demonstrated efficacy in increasing students' health-related knowledge (i.e., fitness knowledge)²¹ through relevant kinesthetic learning experiences.²² CBPE is centered on students' learning of essential concepts that have high relevancy to PA and movement and can be intertwined with students' kinesthetic experiences during PE classes. In a CBPE curriculum, students usually work with a partner to elicit active social processing. Written assignments such as a workbook or task sheet are distributed to student pairs to "think, pair, and share" on tasks that demand mental engagement and problem-solving.^{20,23,24} Prior research supports that completing written assignments that are concomitant to movements in a CBPE curriculum enables students to make a better connection between learning tasks and their lived experiences, which ultimately enhances knowledge achievement.^{20,25}

Students' engagement and learning are largely influenced by the learning content or educational context.²⁶ Students tend to be more attentive and engaged, and achieve more when they are exposed to a motivating and interesting educational environment.^{20,26-28} For this reason, it is relevant to assess students' situational interest when they experience a CBPE curriculum. Situational interest is defined as the appealing effect generated by the setting or a learning task on the learner.²⁶ Situational interest has an immediate motivational impact on the learner. Five sources of situational interest have been identified by previous research in PE: perceived novelty, challenge, attention demand, exploration, and instant enjoyment.²¹ Specifically, novelty refers to the information deficiency between

the known and the unknown. Challenge is defined as the difficulty of a task relative to a learner's ability. Attention demand refers to the concentrated cognition and mental energy required for a learner to focus on a task. Exploration is conceptualized as the learning aspects that drive the learner to explore and discover. Instant enjoyment refers to the characteristics of a task that lead the learner to an instant positive feeling of being satisfied.²¹

Teacher's attitude toward an externally designed curriculum may largely determine the degree to which the curriculum is implemented in reality.²⁹ Our review of the research literature located little evidence to inform the teachers' perceptions of CBPE curricula. One ethnographic study that examined the implementation fidelity of the *Science, PE, and Me* curriculum demonstrated that there were institutional (e.g., school contextual constraints) and personal factors (e.g., personal values and preferences) that might stand out and hinder a teacher's decisions to faithfully implement the prescribed CBPE lessons in their PE classes.³⁰ The finding from this study suggests the need to examine the teachers' perceptions of a new CBPE curriculum based on their firsthand implementation.

This study capitalized on addressing the following questions: (a) To what extent is the CBPE unit effective in physically and cognitively engaging students, and stimulating situational interest in class? (b) To what extent is the CBPE effective in increasing students' EB knowledge? (c) How do PE teachers perceive their experiences teaching the CBPE lessons? First, the CBPE tasks were carefully designed to elicit PA and movement, thus students receiving the CBPE lessons were hypothesized to be as physically active as those in receiving regular PE lessons. Furthermore, each main activity was developed for students to make connections between EB knowledge and their kinesthetic experience. The CBPE lessons, along with the frequent use of written task sheets, should be able to elicit students' active cognitive engagement and learning. Altogether, the physical and cognitive tasks were hypothesized to sustain students' situational interest in the CBPE classes. Second, as a unit guided by relevant theories (e.g., social constructivist learning theory) and experiences of the curriculum developers, the CBPE unit was hypothesized to increase the students' EB knowledge achievement as its intended outcome. Third, there are many challenges to teach a constructivist curriculum by teachers³⁰ in reality; thus, it was anticipated that the CBPE unit would be perceived as having both strengths and weaknesses.

2. Methods

2.1. Setting and participants

This study was carried out in a fringe town (<10 miles from a metropolitan area) school district located in a mid-western state of the United States between February and April of 2015. The district had four elementary schools with a total enrollment of 503 4th and 5th grade students in the academic year. Three of the four schools had three classes per grade, while the other school had two classes per grade; thus, there were eight classes for each grade. The majority of the students in the district were white (92%); boys (52%) and girls (48%) were evenly distrib-

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