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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.

Keywords: Cognitive engagement; Constructivist learning theories; Curriculum intervention; 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

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(i.e., using 2 EB lessons) only demonstrated marginal effects on 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 teachers[30] 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 4 elementary schools with a total enrollment of 503 fourth and 5th grade students in the academic year. Three of the 4 schools had 3 classes per grade, while the other school had 2 classes per grade; thus, there were 11 classes for each grade. The majority of the students in the district were white (92%); boys (52%) and girls (48%) were evenly distributed; and 27% of the students were eligible for the free or

reduced price lunch program. PE classes were 30 min in duration and taught by certified PE teachers every 3 days.

Using a quasi-experimental research design, the 4 schools were randomly assigned to the CBPE group or the control group before data collection started. De-identified data were collected from the participants ($n=468$; CBPE group: $n=257$; control group: $n=211$). The sample was evenly distributed by grade (4th grade: $n=231$, 49%) and sex (girls: $n=220$, 47%), with 77% reporting as white for race/ethnicity. Interview data were collected, with permission, from 2 participating PE teachers teaching CBPE (all males), who on average had about 10 years of teaching experiences. They were the only PE teachers at the 4 schools. The study was approved by the Institutional Review Board (IRB) of the Iowa State University, and the participating school district and school principals. Parental consent and student assent were waived by the IRB, and informed consent from the 2 teachers was secured prior to the interviews.

2.2. The curricula

2.2.1. The CBPE curriculum

Two schools were randomized to the experimental group to receive the CBPE for EB education. The CBPE unit for EB education was developed by the lead author with assistance from an expert team. The unit consisted of 11 lessons addressing content modules such as energy in, energy out, EB, and body composition, with lesson objectives and lesson foci in alignment with the latest national PE standards in the United States.[31] Detailed lesson plans were created and PE teachers were required to closely follow these lesson plans. Each lesson included a warm-up, a main activity, and a cool-down. No specific warm-up activities were prescribed to allow some autonomy for the teachers. Instead, teachers were suggested to offer active, dynamic, and fun instant activities for warm-up during the first 5 min of the lesson. In the next 20 min, each lesson had at least 1 main activity to cognitively and physically engage students on the EB related topics. Students were expected to perform each task with a partner who stayed together throughout the unit. Student pairs participated in the activities and completed the task cards together. All students wore a pedometer to monitor their steps and assist their learning of concepts such as calorie and energy. For example, the main activity of Lesson 1 was "Count My Steps". In the activity, the instruction was centered on a focus question of "How can you tell if you are active?" (Answer: You can use a pedometer to measure it). The student pairs were then engaged in 4 stations of 2−3 exercises for 12 min (3 min each station). The 4 stations consisted of resistance-training activities, aerobic fitness activities, light intensity sports activities, and more strenuous activities, which were distinguishable using the pedometer. The student pairs performed the exercises collaboratively and recorded their steps at the end of each station. The task sheet has 1 problem-solving question asking the purpose of using a pedometer, in addition to documenting the step count generated by the station activities. Each lesson concluded with a cool-down period that included teacher-chosen static stretching activities and a structured closure with questions and answers to reinforce the knowledge learned from each lesson. Table 1 shows the content and main activity for each lesson of the CBPE unit. The lesson plans were intensively discussed and approved by an expert panel comprised by 3 pedagogy researchers and 2 experienced elementary school PE teachers. Six of the 11 lessons were piloted in a home-school PE program with 4th and 5th grade students in the fall semester of 2014. The lesson plans were printed on booklets and distributed to the participating PE teachers. No standard training was provided, as it was believed by the expert panel that the lesson plans would be executable by any PE teachers.

2.2.2. The control curriculum

The 2 schools that were randomized to the control group proceeded with their regular curriculum. These schools were located in the same school district as the other 2 schools; therefore, PE scheduling was identical with PE classes every 4 days for 30 min each. The PE lessons during the data collection period were characterized by short instructional units on a variety of activities or content ranging from sports (e.g., hockey, bowling) to fitness activities (e.g., push-ups, sit-ups, jump rope, jogging, running, and dynamic walking). Both PE teachers mainly followed a direct teaching style, where students passively followed the instruction in a typical lesson.

Table 1
The scope and sequence of the CBPE unit on EB education.

Lesson	Module	Concept	Main activity
1	Energy out	PA; intensity; steps measurement	"Count My Steps"
2	Energy out	PA intensity; target heart rate zone	"Target Heart Rate Zone"
3	Energy out	Energy out; PA, intensity	"Energize My Steps"
4	Energy in	Food groups; energy in	"Choose My CHEWs"
5	Energy in	Food groups; energy in; balanced meal; empty calories	"Snack Attack"
6	Energy in/balance	Energy in/balance; PA	"Energy Beanbags"
7	EB	Energy in; EB	"Bowl to Balance"
8	EB	Energy in; EB; fruits and vegetables	"Capture the Fruits and Veggies"
9	EB	Food groups; PA; EB	"Eat to Move"
10	EB	Fat; EB	"Healthy and Unhealthy Fat"
11	Body composition	Body composition; fat tissues; lean tissues; healthy diet; exercise	"Fat Cell Tag and Ultimate CHEW"

Abbreviations: CBPE = concept-based physical activity; EB = energy balance; PA = physical activity.

2.3. Instrumentation

2.3.1. Fidelity checklist

To determine the effects of the CBPE unit, it was critical to first fathom the extent to which the CBPE lessons were implemented, and what and how the regular PE (control) was taught. Therefore, researchers designed checklists (1 per lesson) to check whether or not the key elements of each CBPE lesson were taught as scripted on the lesson plans. The number of questions on these checklists ranged from 12 to 15, with all but 1 being Yes or No Questions (1 open-ended question was included for the observer to detail deviations from the lesson plans). For example, Question 11 for the checklist of Lesson 1 asks: "Did the students perform cool-down activities (e.g., stretch) at the end of class?" (Yes or No). The observation protocol for the control group was more generic in scope, which prompted the observer to draw a diagram of the setting, document what and how the content was being taught (teacher and students' actions) sequentially. All observers received a 1-h training on how to use the checklists prior to data collection. These checklists and observation protocol are available by request.

2.3.2. EB knowledge

EB knowledge was pre- and post-measured by a validated written test in both groups. The test has been validated using the Rasch model analysis, and the paper that reports the results is currently under review.[32] The test contains 24 multiple choice questions, each with 4 answer choices. There is only 1 correct answer to each question (see an example below). Students' test sheets were scored to the answer key. Percent correct score for each student was subsequently calculated by dividing the number of correct responses by the total number of items. A sample item displays below:

Q19. Which is the best plan for maintaining a healthy weight?

a. *Stop eating some food because they are not healthy.*
b. *Not to worry about what you eat, just be active.*
c. *Eliminate all fats from your diet.*
d. *Try to balance the calories that you take in with your energy needs (correct).*

2.3.3. Situational interest

Situational interest was measured in both the CBPE and control groups using the Situational Interest Scale—Elementary (SIS-E).[21] The SIS-E consists of 15 four-point Likert-type items that measure 5 sources of situational interest (i.e., novelty, challenge, attention demand, exploration, and instant enjoyment). When responding to the SIS-E, students were asked to think about the PE classes in the past 2 weeks. For example, an item that measures "attention demand" states: "My PE classes demanded me to pay." The answer choices include (a) high attention, (b) some attention, (c) a little attention, and (d) no attention. Previous validation studies have shown sound construct validity and internal consistency reliability for the SIS-E.[21] The internal reliability consistence for the 5 situational interest constructs ranged from 0.65 (exploration) to 0.84 (instant enjoyment) for the sample recruited in this study. A high composite average score indicates high level of situational interest.

2.3.4. Physical engagement in class

Students' physical engagement during the CBPE and regular PE lessons was measured by their active and sedentary time (in minutes), using the GT3X+w accelerometers (ActiGraph, Pensacola, FL, USA). Trained data collectors went to the 4 schools during their respective PE classes to help the students use the monitors. The ActiGraph GT3X+w is an unobtrusive triaxial accelerometer-based PA monitor capable of estimating PA intensity and volume. The arithmetic means for moderate-to-vigorous physical activity (MVPA), light PA (LPA), and sedentary time were computed to reflect the students' physical engagement during their PE classes. The monitor was set up in 10 s epoch and 30 Hz for sampling frequency during initialization on ActiLife Version 6.0 (ActiGraph). Cut-points based on Freedson et al.[33] equation for 9- (4th grade) or 10- (5th grade) year-old children were used to calculate the minutes of MVPA (i.e., $\geq$3 METs), LPA (i.e., 1.5−2.9 METs), and sedentary time (i.e., $<$1.5 METs). The monitor was previously validated and used to measure free-living PA and sedentary behavior in youth.[34]

2.3.5. Cognitive engagement in class

Students' cognitive engagement was only measured in the CBPE group due to its focus on cognitive learning. It was measured by a booklet of 11 task sheets, 1 per CBPE lesson. The task sheets have completion-based tasks that prompt students to record their behaviors (e.g., number of steps) and problem-solving based questions. For example, after experiencing the "Bowl to Balance" game, Question 4 on task sheet of Lesson 7 asks students, "Which food is easier to counter using PA, higher-energy snacks or vegetables of the same amount?" Each task sheet was completed in pairs who stayed together throughout the entire unit. A validated scoring rubric (intensive discussions between 2 researchers) was applied to score the completed task sheets by a research assistant who was not involved in the curriculum development process. The task sheet score range varied from 0−2 to 0−4 for different CBPE lessons, making the grand score range (for all 11 lessons) 0−31. Percentage correct score was computed to quantify each student pair's level of cognitive engagement.

2.3.6. Teacher's perceptions

The PE teachers who taught the CBPE lessons were interviewed to reveal their perceptions. Following a pre-established interview guide, 2 separate semi-structured interviews with probe questions were conducted with the 2 PE teachers. The interview guide is detailed in Table 2. The interviews took place in a quiet room chosen by the PE teachers (i.e., office, school library) and each lasted for approximately 25 min. The interviews were recorded using a digital recorder with the teachers' permission.

2.4. Data collection

Five data collectors (undergraduate and graduate students majoring in Kinesiology and Health) were trained to collect data at schools following a standardized protocol. On each data collection day, a data collector arrived 15 min prior to the class

Table 2
The guide to interview the PE teachers who taught the CBPE unit.

Stage	Interview content
Introduction and warm-up	Thank you for implementing the CBPE lessons for us in your PE program! This was a rather long project. I understand how difficult it was for you to teach all the lessons. Today, I just have several questions for you to get a sense of your perceptions and opinions about the implementation process. To hear you clearly, I'd like to record our conversation, if that's okay with you. All information based on our conversation will be kept confidential.
Main questions	1. In general, how many of the CBPE lessons did you teach to your students? 2. What are your general thoughts on the CBPE unit (general pros and cons)? 3. When you were first asked to teach the CBPE lessons, what were your thoughts or reactions to these lessons? 4. Did these thoughts change overtime after teaching more lessons? Please describe these changes. 5. Did your students like these CBPE lessons? Which lessons did they like the most? Which lessons were their least favorite ones? 6. What were the benefits, as you perceive, of teaching the CBPE unit to these 4th and 5th grade students? 7. What were the barriers for teaching these lessons? 8. I know there might be some issues with the CBPE lessons. You also have experienced some. What would you recommend for future changes to make the lessons more relevant and teachable for students elsewhere in the state?
Exit of interview	Well, that concludes our interview conversation. Besides to what we have talked about today, do you have anything else to add? Thank you for your contribution.

Abbreviations: CBPE = concept-based physical education; PE = physical education.

to set up. In the CBPE schools, task sheets and pencils were distributed to the students at the beginning of each class by the PE teacher, and collected at the end, with the data collector's assistance. When observing each class, the data collector completed pre-established checklists to quantify the fidelity of implementation as the CBPE lessons were delivered. The data collector and the PE teacher ensured that all students wore the GT3X+w accelerometer and pedometers (for instructional purpose) on their waists during the targeted lessons (i.e., odd numbered lessons in 1 school and even numbered lessons in the other school). The detailed schedule of PA assessment is shown in Table 3. In the control schools (regular PE), data collectors' main responsibility included observing the PE classes, taking field notes on the observation protocol sheet, and helping all the students wear the accelerometers on those measurement days (every other PE lesson). Pre- and post-measurements of students' EB knowledge were taken online via www.Qualtrics.com in all 4 schools. The students completed the knowledge test independently on an assigned computer located in the school's media center, under the supervision of the PE teacher and with instructions from at least 1 trained data collector. Mid- and post-measurements of situational interest were administered using paper and pencils in the gyms. Mid-measurement was completed between Lesson 5 and Lesson 7 of the CBPE unit. The completed booklets of task sheets from the CBPE schools were picked up at the end of the project. The PE teachers who taught CBPE were individually interviewed by the lead researcher at the end of the instructional unit. Trustworthiness of the interview data was ensured through member checking. The impact of subjective bias was reduced or minimized by bringing the interview transcripts back to the 2 interviewed teachers and allowing them an opportunity to correct errors and provide additional information to the verbatim.

Table 3
Accelerometer data collection schedule in the 4 schools.

Lesson number	School 1 (CBPE)	School 2 (CBPE)	School 3 (control)	School 4 (control)
Lesson 1	x		x	
Lesson 2		x		x
Lesson 3	x		x	
Lesson 4		x		x
Lesson 5	x		x	
Lesson 6		x		x
Lesson 7	x		x	
Lesson 8		x		x
Lesson 9	x		x	
Lesson 10		x		x
Lesson 11	x		x	

Notes: x means ActiGraph accelerometer data were collected in the lesson at the school. Trained data collectors were sent to the schools to observe the lessons and help the students wear the accelerometers.
Abbreviation: CBPE = concept-based physical education.

2.5. Data reduction

The checklist responses were entered into an Excel Version 2010 (Microsoft Crop., Redmond, WA, USA) spreadsheet by a trained data analyst. The EB knowledge data from the test were downloaded from the Qualtrics website and binary-coded (0 = incorrect, 1 = correct), while the situational interest data were aggregated by construct (i.e., challenge, attention demand, exploration, and instant enjoyment). Knowledge and situational interest data were saved in Excel and then in SPSS Version 21.0 (IBM Crop., Armonk, NY, USA) for analysis. The completed task sheets were scored using a pre-established rubric and percentage correct scores were computed using Excel. Accelerometer data were reduced using Stata Version 13.1 (StataCorp LP, College Station, TX, USA). Interviews were transcribed into verbatim. All data were saved, organized, and cleaned for subsequent data analysis at the lead researcher's lab.

2.6. Data analysis

Percentage of consistency between each lesson plan and actual instruction was computed to quantify the fidelity of implementation using the checklist data. Percentage scores of the students' task sheets were calculated following a validated rubric to show the level of cognitive engagement. To rule out

the nesting effect on the outcome variables (students nested within teachers or schools), intra-class correlations (ICCs) were computed for the pre-test scores (situational interest constructs and EB knowledge) using EQS Version 6.1 (Multivariate Software, Inc., Temple City, CA, USA). Two-way ANOVA was conducted using EB knowledge as dependent variable and time and group as independent variables. Both main and interaction effects were tested in the analyses. MANOVA was conducted to test the group and time effects of the 5 situational interest constructs. Descriptive statistics such as mean ± SD of the activity (MVPA, LPA, and sedentary behavior) time (in minutes) were reported by group (i.e., CBPE *vs.* control). Analyses of variance (ANOVAs) were conducted to detect statistical difference in physical engagement between the 2 groups. Partial eta square (η^2) was reported as effect size (small = 0.01, medium = 0.06, large = 0.14). The interview data were analyzed using inductive analysis.[35] The third author began by reading each interview verbatim and using open coding of the transcriptions. The first and third authors then collaboratively reviewed these codes to further focus the data, identify summative codes, and reduce the codes to emerging categories. Definitions of the categories were created and accompanied by their properties and dimensions.

3. Results

3.1. Fidelity checklist

Every other CBPE lessons (odd numbered lessons in one school, even numbered lessons in the other school) were directly observed by trained data collectors for fidelity check. Both PE teachers decided to combine Lesson 1 with Lesson 3 and Lesson 2 with Lesson 4 to shorten the cycle of the unit. A total of 103 (out of 108: 9 lessons × 12 classes) checklist sheets were completed (School 1: $n = 54$; School 2: $n = 49$), with 5 checklist sheets missing (for weather reason). These checklist records showed that the PE teachers closely followed the prescribed CBPE lesson plans, other than the decision to teach 2 combined lessons as opposed to 4 individual lessons. They implemented the lesson plans with compliance rates as high as 89% and 92%, respectively, suggesting that the lessons were implemented with relatively high fidelity. For the control group, trained observers were sent to schools concurrently with the CBPE schools. Detailed notes were taken to describe the setting, teaching and learning actions sequentially from beginning to the end. These field notes were processed to describe the characteristics of the comparison curriculum.

3.2. EB knowledge

Table 4 shows the EB knowledge scores by time and group. Students showed moderate levels of EB knowledge at the baseline. The baseline difference between the CBPE and control groups was small. The baseline comparison result indicates that the students were at a similar starting point before the study. The ICC between the 4 teachers or schools for pre-test EB knowledge was 0.14, indicating that there was a small clustering effect and independent data observations for EB knowledge. However, after receiving the CBPE unit, students in the experimental group significantly improved their EB knowledge (by about 14%), while the control group did not show a significant increase (by less than 2%). Two-way ANOVA showed significant group ($F(1, 928) = 51.31$, $p < 0.01$, $\eta^2 = 0.05$), time ($F(1, 928) = 74.35$, $p < 0.01$, $\eta^2 = 0.07$), and group × time effects ($F(1, 928) = 43.88$, $p < 0.01$, $\eta^2 = 0.05$).

3.3. Situational interest

Table 4 also shows the mean scores of the situational interest sources by time and group. The situational sources were relatively low to moderate, but nearly all sources (except "challenge" for the experimental group) showed an increasing trend from mid-test to post-test for both the CBPE and control groups. The ICCs for all situational interest constructs were rather small (ICC coefficients = 0, 0.01, 0.03, 0.03 for challenge, attention demand, instant enjoyment, and exploration, respectively) except for novelty (ICC coefficient = 0.21), indicating that there was none to minimal clustering effect and the data observations for situational interest constructs were independent across the teachers or schools. Table 5 shows the bivariate Pearson correlation coefficients for the situational interest sources from the 2 respective measurement time points, with correlation coefficients ranging from 0.29 to 0.65.

Due to the violation of independent observation, novelty was not included for MANOVA and we only reported mean comparisons for the variable. The Box's test of equality of

Table 4
Descriptive results for EB knowledge (%) and situational interest constructs (mean ± SD).

Variable	Time of testing	Control group	CBPE group
EB knowledge	Pre-test	53.3 ± 13.2	53.8 ± 14.0
	Post-test	55.1 ± 14.9	67.9 ± 13.9
Attention demand	Mid-test	1.65 ± 0.56	1.58 ± 0.58
	Post-test	1.89 ± 0.65	1.73 ± 0.63
Instant enjoyment	Mid-test	1.67 ± 0.61	1.84 ± 0.78
	Post-test	1.78 ± 0.70	2.02 ± 0.83
Challenge	Mid-test	2.63 ± 0.71	2.53 ± 0.64
	Post-test	2.72 ± 0.74	2.44 ± 0.66
Novelty	Mid-test	2.34 ± 0.65	1.80 ± 0.56
	Post-test	2.46 ± 0.76	1.89 ± 0.58
Exploration opportunity	Mid-test	2.41 ± 0.71	2.17 ± 0.65
	Post-test	2.59 ± 0.79	2.25 ± 0.64

Abbreviations: CBPE = concept-based physical education; EB = energy balance.

Table 5
Correlation matrix for the situational interest variables.

	1	2	3	4	5
1. Attention demand	–	0.62	0.56	0.58	0.64
2. Instant enjoyment	0.65	–	0.34	0.42	0.44
3. Challenge	0.41	0.29	–	0.55	0.64
4. Novelty	0.44	0.34	0.39	–	0.63
5. Exploration	0.53	0.47	0.45	0.50	–

Note: Correlation coefficients below the diagonal line are from the mid-assessment; correlation coefficients above the diagonal line are from the post-assessment.

Table 6
Follow-up ANOVA summary table of situational interest constructs (time and group).

Variable	Situational interest construct	*SS*	*df*	*MS*	*F*	*p*	η^2
Intercept	Attention demand	2472.37	1	2472.37	6793.13	0.00	0.89
	Instant enjoyment	2799.17	1	2799.17	5197.30	0.00	0.86
	Challenge	5602.81	1	5602.81	11977.84	0.00	0.93
	Exploration	4662.54	1	4662.54	9643.48	0.00	0.92
Time	Attention demand	8.66	1	8.66	23.79	0.00	0.03
	Instant enjoyment	4.85	1	4.85	9.01	0.00	0.01
	Challenge	0.01	1	0.01	0.02	0.90	0.00
	Exploration	3.18	1	3.18	6.58	0.01	0.01
Group	Attention demand	3.25	1	3.25	8.92	0.00	0.01
	Instant enjoyment	8.02	1	8.02	14.89	0.00	0.02
	Challenge	9.03	1	9.03	19.30	0.00	0.02
	Exploration	18.40	1	18.40	38.05	0.00	0.04
Time × group	Attention demand	0.41	1	0.41	1.13	0.29	0.00
	Instant enjoyment	0.33	1	0.33	0.61	0.44	0.00
	Challenge	1.74	1	1.74	3.72	0.05	0.00
	Exploration	0.56	1	0.56	1.15	0.28	0.00
Error	Attention demand	307.54	845	0.36			
	Instant enjoyment	455.10	845	0.54			
	Challenge	395.26	845	0.47			
	Exploration	408.55	845	0.48			
Total	Attention demand	2799.67	849				
	Instant enjoyment	3305.56	849				
	Challenge	6009.00	849				
	Exploration	5084.33	849				

Abbreviations: *df* = degree of freedom; *MS* = mean square; *SS* = sum of squares.

covariance matrices showed significance (Box's $M = 79.24$, $p < 0.01$); therefore, Pillai's Trace results were reported.[36] MANOVA showed significant main time ($F(4, 842) = 7.65$, $p < 0.01$, $\eta^2 = 0.04$) and group effects ($F(4, 842) = 29.37$, $p < 0.01$, $\eta^2 = 0.12$). No time × group interaction effect was observed ($F(4, 842) = 1.97$, $p = 0.10$, $\eta^2 = 0.01$). Subsequent univariate ANOVAs showed significant time effect favoring post-test scores (except for challenge: $F(1, 849) = 0.02$, $p = 0.90$) and significant group effect favoring the control group. Table 6 shows the ANOVA results for each of the situational interest constructs. Although novelty was not included for inferential statistical analysis due to the clustering effect, the mean comparisons by time and group showed similar trend as other situational interest constructs (favoring post-test and control group).

3.4. Physical engagement

Students' physical engagement during PE class was captured by their aggregated active and sedentary time. Fig. 1 shows the comparison of average in-class PA and sedentary time between CBPE and control schools. The 2 groups showed similar MVPA (9.80 min *vs.* 11.09 min), light PA (5.66 min *vs.* 6.41 min), and sedentary time (12.52 min *vs.* 10.97 min). The combined PA (i.e., sum of MVPA and LPA) time for both the CBPE and control groups exceeded 15 min (i.e., 50% of the allotted class time). ANOVAs found that MVPA ($F(1, 467) = 12.20$, $p < 0.01$, $\eta^2 = 0.005$), LPA ($F(1, 467) = 87.04$, $p < 0.01$, $\eta^2 = 0.033$), and sedentary behaviors ($F(1, 467) = 7.17$, $p < 0.01$, $\eta^2 = 0.003$) were statistically different between the CBPE and control groups, favoring the control group. However, since the effect sizes for both MVPA and sedentary behaviors fall in the "small" category, it was determined that the 2 groups did not substantively differ in physical engagement (MVPA, LPA, and sedentary behavior time). The statistical significance was inflated by the large sample size (i.e., $n = 468$).

3.5. Cognitive engagement

The average total score for the task sheets was 63.6% (SD = 12.1%), suggesting a moderate level of cognitive engagement. The 2 CBPE schools showed rather similar levels of in-class student cognitive engagement (i.e., 61.3% for School 1 *vs.* 65.6% for School 2).

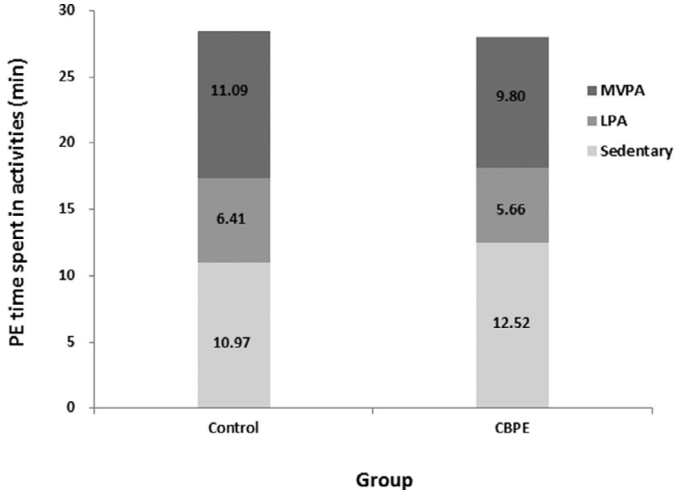

Fig. 1. Distribution of physical education class time by intensity of activity. CBPE = concept-based physical education; LPA = light physical activity; MVPA = moderate-to-vigorous physical activity.

3.6. Interview results

The interview results indicate that aside from the high fidelity of implementation of teaching the CBPE lessons, both teachers perceived strengths and limitations. For strengths, they valued the cognitive and physical learning objectives of the CBPE lessons, particularly in the areas of "nutrition (EB)", "new content (to PE)", "group-based games", and "technology". For example, interviewees noted: "What I believe kids need to start to pay attention to, is the nutritional part" and "To really understand what you are putting into your body and how it affects you." Interviewees believed that "...using technology, just something new, (like) pedometers, accelerometers" was effective at engaging and teaching children to use technology to track PA. Most of the lessons were also acknowledged to interest students in class. Key words such as "interested", "fun", and "enjoyed" were frequently mentioned by the teachers.

The PE teachers perceived "time limitation" as a hindrance to implementing content in the CBPE unit that they valued. Both PE teachers valued the content to the extent that they would again use the unit in the future. They felt that "...there is a lot of good information that the kids got out of it" and that being the case, it would be better if they could disperse the content "...over the course of a whole semester" or "...stretch it out over 2 quarters, instead of trying to squeeze it in" during a focused unit. This was not a deviation from the CBPE lesson plans by the teachers in this case but rather a suggestion by the PE teachers for future implementation of the unit. More time for instruction, answering questions, and increasing PA engagement would be desirable to transform the negative experiences into positive ones. In addition, the teachers recognized content redundancy for certain lessons (e.g., Lesson 1 and Lesson 3, Lesson 2 and Lesson 4). This realization urged them to decide to combine these lessons by condensing the content.

4. Discussion

The purpose of this study was to evaluate the effects of a CBPE instructional unit themed by EB education on students' EB knowledge, situational interest, and cognitive and physical engagements, and teachers' perceptions of the CBPE unit. The study overall followed a quasi-experimental research design and reported both quantitative and qualitative findings that carry significant implications. The findings are discussed below.

4.1. Effects on EB knowledge and physical engagement

It was found that the CBPE group demonstrated a significant increase in EB knowledge, while the control group did not. This finding was expected, which confirmed our hypothesis, as the curriculum priority of the CBPE unit was to enhance 4th and 5th grade students' EB knowledge (i.e., knowledge of most worth for this unit). The construction of the lesson plans was guided by the social constructivist learning theories[15,16] and the curriculum developers' theoretical and practical experiences. Essential EB concepts were purposely linked to active movement tasks in PE classes so that students could learn knowledge through meaningful kinesthetic experiences. Subsequently, the participating PE teachers were able to implement the lessons with a reasonably high level of compliance. The curriculum and instruction collectively enabled a successful curriculum intervention for EB education, as reflected by the increase in EB knowledge.

In PE, students should be engaged in fun and meaningful PAs, on top of attaining other educational objectives.[37,38] The finding above should be interpreted along with the physical engagement results. For this reason, we objectively quantified the actual minutes spent in MVPA, LPA, and sedentary behavior, and compared the results between the 2 types of PE curricula (see Fig. 1 for specific results). Statistical analyses showed that although physical engagement (i.e., MVPA, LPA, and sedentary behavior) favored the control group ($p < 0.05$), the actual inter-group differences in minutes were minimal, and the level of significance was mainly inflated by the large sample size ($n = 2520$ data entries analyzed).[39] Therefore, we conclude that the 2 types of curricula demanded similar levels of physical engagement during the instructional processes. The 2 findings above corroborate the conclusion from a large-scale curriculum intervention study that a CBPE curriculum, when designed and executed properly, has the efficacy to enhance students' health-related knowledge (e.g., EB knowledge, fitness knowledge) without compromising their in-class PA.[22,40] Nonetheless, there is much room to make these lessons more physically active. Field observation of the teaching process in the CBPE group demonstrated that the teachers spent more time than suggested explaining the concepts or managing student behaviors, especially during the early lessons of the unit. This was not surprising given the fact that neither the teachers nor the students had previously been exposed to a CBPE curriculum. As a result, it took the teachers longer to convey instruction to the students. In addition, a lesson-by-lesson analysis of the in-class PA for the CBPE lessons (not reported in this paper due to page limit) showed varying MVPA time within the unit, with some lessons (e.g., Lessons 5 and 9) showing less MVPA time than others. Further revision effort should be given to these less active lessons to make them more physically engaging for students.

4.2. Effects on situational interest and cognitive engagement

The level of situational interest represents how interesting the students perceive the learning experiences to be.[21,26] The findings from this study showed no time by group interaction effect in any of the situational interest constructs (both groups showing a similar trend of change), although the control group showed more favorable results at both mid- and post-measurements for all constructs except instant enjoyment and challenge. The group differences for situational interest constructs could be originated from the actual individual differences for the students in the CBPE group and those in the control group, or the differences may be attributable to the possibility that the CBPE lessons were not as situationally interesting to the students. These findings suggest the need to refine the CBPE lessons to make them more interesting, by carefully attending to each source of situational interest, in particular, perceived novelty, challenge, attention demand, and exploration.[21,41] For example, several lessons used fundamental locomotor movements such as skipping and

galloping, which are still relevant to 4th and 5th grade students but may not be as novel and attractive as sports activities. In comparison, sports activities were taught as main content in some of the PE lessons in the control group. Furthermore, students are accustomed to traditional PE lessons that are enriched with free play or non-competence-based learning experiences,[42] where they may have more autonomy to participate and socialize. However, the CBPE was a focused unit on EB education, which could be perceived as more rigid but less explorative. Also found in the present study was that the students did find the CBPE lessons more enjoyable but less challenging than the comparison lessons. Future revision of the CBPE lessons should take into account the above situational interest constructs to make the curricular experiences more situationally interesting.

The level of cognitive engagement, as indicated by the mean score of the task sheets (i.e., 63.6%), is moderate and has room for improvement. Since there are no criteria or findings from other studies to compare the level of cognitive engagement for PE, a plausible explanation for the moderate level of cognitive engagement may lie in the fact that the PE teachers and students were not accustomed to the use of a task sheet. Previous research has shown that it is challenging to implement a constructivist PE curriculum,[30] and strategies intended to address these challenges should be enforced. Nevertheless, the use of written task sheets in PE classes was indeed a useful tool in the CBPE unit to prompt and facilitate students' cognitive engagement. As shown in previous research, students' cognitive engagement (with task sheets or workbooks) is associated with knowledge learning.[20,25] Specifically, Zhu et al.[20] found in their study that no to low level of engagement with the workbook (similar to the task sheets used in the present study) led to little knowledge achievement, while correct performance in solving in-class cognitive problems was significantly associated with knowledge gain. Future research should further explore the utility of task sheets in PE. Particularly, further data analysis would be necessary to unravel the nature and qualification of these task sheets (e.g., to find out which task sheets are more engaging, and how to refine and improve them to entice students' cognitive engagement).

4.3. Teachers' perceived experiences teaching the CBPE lessons

As shown in the interview results, the 2 PE teachers who taught the CBPE unit perceived that the lessons that are themed by EB-related concepts such as diet and PA are beneficial and useful for children to learn weight management skills for obesity prevention. This perceived benefit was recognized and endorsed by the teachers, and probably had enabled them to maintain a relatively high level of implementation fidelity (92% and 89%), when they were teaching the CBPE lessons. High implementation fidelity is critical to the success of a curriculum intervention. High fidelity makes it possible for the researchers to attribute intervention effect to the curricular treatment. Deviations from the curriculum that did occur were minor except the fact that both PE teachers chose to teach combined lessons (Lessons 1 and 3, Lessons 2 and 4). Their rationale for making such deviation was that they felt that in "the time frame of 30 min" per lesson (for a quarter of a semester) they needed to attend to other priorities such as "answer students' content questions", "give directions on use of equipment", and "maximize PA", all of which fell under the category of "Time" as one of the "Limitations". The deviations fall into the teachers' enactment of an externally designed curriculum unit.[43] It is encouraging that most of the lessons in the CBPE unit are within the teachers' zone of enactment;[43] that is, they were able to teach most lessons comfortably as the way the lessons were designed. Overall, the findings demonstrated that the teachers valued the unit of instruction on EB education that was faithfully taught in a gymnasium setting.

4.4. Strengths and limitations

The strengths of this study include (a) expert-validated curriculum unit, (b) large sample size, (c) quasi-experimental research design, (d) sound measures, and (e) robust data analyses. The study also has several limitations. First, cognitive engagement was not measured in the control group, which made its comparison against the CBPE group impossible. Second, some of the lessons in the CBPE unit could have been better designed to be physically demanding and situationally interesting. As a piloting effort, the evaluation results have identified areas for further improvement. Third, the qualitative data derived from the individual teacher interviews could be further triangulated with other sources of teacher-level data (e.g., teacher journal, reflection). Last but not the least, only 1 field observer was sent to each school for fidelity check; hence, it was not feasible to assess the inter-rater reliability of the observation data. However, each observer received intensive training prior to data collection and the observation protocols were designed to be easy to administer. For these limitations, the research findings should be interpreted with prudent caution.

5. Conclusion

The CBPE unit implemented in this study rendered a positive effect on 4th and 5th grade students' EB knowledge achievement through active movements. The lesson plans were executed by the teachers who valued and appreciated the implementation of the unit in their respective PE programs. The lessons were perceived interesting and both physically and cognitively engaging. Aside from the immediate in-class effects on student situational interest and engagement (both physical and cognitive engagement), which are confirmed in this paper, the CBPE unit may give rise to important lingering educational effects on knowledge competence that may carry over across the lifespan.[44,45] Such educational experiences are essential as PE professionals strive to prepare students to be "on their own" as capable and motivated movers for a lifetime.[46] The evaluation has also disclosed the weaknesses of the current version of the unit. Future effort should strive to make the lessons more physically demanding. The time hindrance or pressure could be alleviated by adding "teacher tips" and allowing for improvisation.

Authors' contributions

SC designed and led the study, analyzed data, drafted and revised the manuscript; XZ assisted data analysis, revised the manuscript; JA analyzed the interview data, helped revise the

manuscript; YHN helped data collection and processing, and revised the manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

References

1. Katz DL, O'Connell M, Njike VY, Yeh MC, Nawaz H. Strategies for the prevention and control of obesity in the school setting: systematic review and meta-analysis. *Int J Obes* 2008;**32**:1780–9.
2. Kriemler S, Meyer U, Martin E, van Sluijs EM, Andersen LB, Martin BW. Effect of school-based interventions on physical activity and fitness in children and adolescents: a review of reviews and systematic update. *Br J Sports Med* 2011;**45**:923–30.
3. Ennis CD. Defining learning as conceptual change in physical education and physical activity settings. *Res Q Exerc Sport* 2007;**78**:138–50.
4. Ennis CD. Examining curricular coherence in an exemplary elementary school program. *Res Q Exerc Sport* 2008;**79**:71–84.
5. National Association for Sport and Physical Education. *Shape of the nation report: status of physical education in the USA*. Reston, VA: American Alliance for Health, Physical Education, and Dance; 2012.
6. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011–2012. *JAMA* 2014;**311**:806–14.
7. Chen S, Chen A. Youth physical activity behavior and energy-balance knowledge: an expectancy-value perspective. *J Teach Phys Educ* 2012;**31**:329–43.
8. Chen S, Chen A. Ninth graders' learning differences in a healthful-living curriculum. *Learn Individ Differ* 2014;**30**:170–6.
9. Dunford M. *Fundamentals of sport and exercise nutrition*. Champaign, IL: Human Kinetics; 2010.
10. Katz DL. Unfattening our children: forks over feet. *Int J Obes* 2011;**35**:33–7.
11. Nelson MC, Lytle LA, Pasch KE. Improving literacy about energy-related issues: the need for a better understanding of the concepts behind energy intake and energy expenditure among adolescents and their parents. *J Am Diet Assoc* 2009;**109**:281–97.
12. Slater ME, Sirard JR, Laska MN, Pereira MA, Lytle LA. Relationships between energy balance knowledge and the home environment. *J Am Diet Assoc* 2011;**111**:556–60.
13. Chen S, Zhu X, Welk GJ, Kim Y. Tracking energy balance in adolescents: levels of compliance, energy flux, and learning. *J Exerc Sci Fit* 2015;**13**:35–41.
14. Chen S, Zhu X, Welk GJ, Kim Y, Lee J, Meier NF. Using SenseWear armband and diet journal to promote adolescents' energy balance knowledge and motivation. *J Sport Health Sci* 2014;**3**:326–32.
15. Light R. Complex learning theory—its epistemology and its assumptions about learning: implications for physical education. *J Teach Phys Educ* 2008;**27**:21–37.
16. Vygotsky LS. *Mind in society: the development of higher psychological processes*. Cambridge, MA: Harvard University Press; 1978.
17. Alexander PA. *Psychology in learning and instruction*. Upper Saddle River, NJ: Pearson Merrill Prentice Hall; 2006.
18. Diakidoy IN, Kendeou P, Ioannides C. Reading about energy: the effects of text structure in science learning and conception change. *Contemp Educ Psychol* 2003;**28**:335–56.
19. Chapman E. Alternative approaches to assessing student engagement rates. *Pract Assess Res Eval* 2003;**8**:1–10.
20. Zhu X, Chen A, Ennis CD, Sun H, Hopple C, Bonello M, et al. Situational interest, cognitive engagement, and achievement in physical education. *Contemp Educ Psychol* 2009;**34**:221–9.
21. Sun H, Chen A, Ennis CD, Martin R, Shen B. An examination of the multidimensionality of situational interest in elementary school physical education. *Res Q Exerc Sport* 2008;**79**:62–70.
22. Chen A, Martin R, Sun H, Ennis CD. Is in-class physical activity at risk in constructivist physical education? *Res Q Exerc Sport* 2007;**78**:500–9.
23. Harrison M, Burns CF, McGuinness M, Heslin J, Murphy NM. Influence of a health education intervention on physical activity and screen time in primary school children: 'Switch Off–Get Active'. *J Sci Med Sport* 2006;**9**:388–94.
24. Salmon J, Booth ML, Phongsavan P, Murphy N, Timperio A. Promoting physical activity participation among children and adolescents. *Epidemiol Rev* 2007;**29**:144–59.
25. Zhang T, Chen A, Chen S, Hong D, Loflin J, Ennis CD. Constructing cardiovascular fitness knowledge in physical education. *Eur Phy Educ Rev* 2014;**20**:425–43.
26. Hidi S, Anderson V. Situational interest and its impact on reading and expository writing. In: Renninger A, Hidi S, Krapp A, editors. *The role of interest in learning and development*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.; 1992. p.215–38.
27. Shen B, Chen A. Examining the interrelations among knowledge, interests, and learning strategies. *J Teach Phys Educ* 2006;**25**:182–99.
28. Shen B, Chen A, Guan J. Using achievement goals and interest to predict learning in physical education. *J Exp Educ* 2007;**75**:89–108.
29. Cheng G, Hsiu Y, Chou WS, Cheng CW. Research into teachers' receptivity for arts infused curricula in Taiwan. *Int J Art Des Educ* 2014;**33**:55–74.
30. Zhu X, Ennis CD, Chen A. Implementation challenges for a constructivist physical education curriculum. *Phys Educ Sport Pedagogy* 2011;**16**:83–99.
31. Society of Health and Physical Educators. *National standards & grade-level outcomes for K-12 physical education*. Champaign, IL: Human Kinetics; 2014.
32. Chen S, Zhu X, Kang M. Development and validation of an energy-balance knowledge test for fourth- and fifth-grade students. *J Sports Sci* 2017;**35**:1004–11.
33. Freedson P, Pober D, Janz KF. Calibration of accelerometer output for children. *Med Sci Sports Exerc* 2005;**37**:(Suppl.11):S523–30.
34. Kim Y, Beets MW, Welk GJ. Everything you wanted to know about selecting the "right" Actigraph accelerometer cut-points for youth, but…: a systematic review. *J Sci Med Sport* 2012;**15**:311–21.
35. Corbin J, Strauss A. *Basics of qualitative research: techniques and procedures for developing ground theory*. 4th ed. Thousand Oaks, CA: SAGE Publications, Inc.; 2015.
36. Tabachnick BG, Fidell LS. *Using multivariate statistics*. 5th ed. Boston, MA: Pearson; 2006.
37. National Association for Sport and Physical Education. *What constitutes a highly qualified physical education teacher [position statement]*. Reston, VA: American Alliance for Health, Physical Education and Dance; 2007.
38. Sallis JF, McKenzie TL, Beets MW, Beighle A, Erwin H, Lee S. Physical education's role in public health: steps forward and backward over 20 years and HOPE for the future. *Res Q Exerc Sport* 2012;**83**:125–35.
39. Zhu W. Sadly, the earth is still round ($p < 0.05$). *J Sport Health Sci* 2012;**1**:9–11.
40. Sun H, Chen A, Zhu X, Ennis CD. Curriculum matters: learning science-based fitness knowledge in constructivist physical education. *Elem Sch J* 2012;**113**:215–29.
41. Sun H. Exergaming impact on physical activity and interest in elementary school children. *Res Q Exerc Sport* 2012;**83**:212–20.
42. Chen S, Chen A, Zhu X. Are K-12 learners motivated in physical education? A meta-analysis. *Res Q Exerc Sport* 2012;**83**:36–48.
43. Spillance J. External reform initiatives and teachers' efforts to reconstruct their practice: the mediating role of teachers' zones of enactment. *J Curriculum Stud* 1999;**31**:143–75.
44. Chen S, Nam YN. Energy balance education in schools: the role of students' knowledge. *Eur Phy Educ Rev* 2016. doi:10.1177/1356336X16641661.
45. Chen S, Sun H, Zhu X, Chen A. Relationship between motivation and learning in physical education and after-school physical activity. *Res Q Exerc Sport* 2014;**85**:468–77.
46. Ennis CD. On their own: preparing students for a lifetime. *J Phys Educ Recreat Dance* 2010;**81**:17–22.