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Effects of a Concept-Based Physical Education on Middle School Students' Knowledge, Motivation, and Out-of-School Physical Activity

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Abstract

Purpose: This study aimed to determine the extent to which a concept-based physical education curriculum, specifically the Science of Healthful Living (SHL) curriculum, influenced middle school students' knowledge, motivation for physical education (PE) and physical activity (PA), and out-of-school PA.

Methods: A static group comparison design was adopted to analyze the differences on fitness knowledge, autonomous motivation for PE and PA, and out-of-school PA between eighth-grade students who studied the SHL curriculum (the experimental condition, $n = 168$) and their peers who studied a multiactivity PE (the control condition, $n = 226$) 1 year earlier.

Results: The students who studied the SHL curriculum demonstrated significantly higher levels of knowledge ($p < .05$, Cohen $d = 0.81$), autonomous motivation toward PA ($p < .05$, Cohen $d = 0.20$), and out-of-school PA ($p < .05$, Mann–Whitney U effect size = 0.01) than students who had experienced the multiactivity PE. The students in both conditions were equally motivated in their respective PE courses.

Conclusion: The SHL curriculum is effective in promoting students' PA behavior outside of the school.

Keywords

autonomous motivation; exercise motivation; PE effect

Lifelong physical activity (PA) promotion has been acknowledged as one primary goal of physical education (PE; Corbin, 2002; Ennis, 2017a; Green, 2014; Society of Health and Physical Educators [SHAPE] America, 2014). This goal implies that PE should emphasize PA promotion not only in school but also outside of the school. Green (2014) referred to the effects of PE on out-of-school PA as the "PE effect" (p. 357). Although the statement of "PE effect" is often cited by physical educators and scholars and is included in many countries' PE policy documentation (Green, 2014), there is little empirical evidence about the effects of

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PE on students' out-of-school PA. The purpose of this study was to examine the "PE effect" of a concept-based physical education (CPE) curriculum.

CPE is defined as a PE curriculum that focuses on teaching conceptual knowledge about PA, fitness, and behavioral skills (Ennis, 2015). Several CPE curriculum models have been available for students in different school levels. For example, Fitness for Life (Corbin & Le Masurier, 2014), Science PE & Me (SPEM; Ennis, 2015, 2017b; Sun, Chen, Zhu, & Ennis, 2012), and Science of Healthful Living (SHL; Ennis, 2015, 2017b; Wang et al., 2017) are three typical CPE curricula that focus on fitness development and PA behavior change.

Empirical studies have shown that high school and college students who have studied the Fitness for Life curriculum tend to be more physically active than students who have experienced traditional sport-based PE (Brynteson & Adams, 1993; Dale & Corbin, 2000; Dale, Corbin, & Cuddihy, 1998, Kulinna, Corbin, & Yu, 2018). For example, Dale and Corbin (2000) compared the PA level between high school graduates who were exposed to Fitness for Life in high school and those who were exposed to traditional sport-based PE. They found that more students in the CPE group reported vigorous PA participation than students in the traditional PE group; fewer students in the CPE were categorized as being sedentary than students in the traditional PE group. A 20-year follow-up study also showed that students who have taken the CPE in high school were more likely to be moderately physically active than national sample age-equivalent peers (Kulinna et al., 2018). Researchers also found that college students who were exposed to CPE demonstrated more knowledge, had a higher positive attitude toward PA, and better PA habit than students who had taken the tradition PE curriculum after graduation from college (Brynteson & Adams, 1993; Slava, Laurie, & Corbin, 1984).

The effects of SPEM and SHL curricula are supported by large-scale, longitudinal (5 years), randomized clinical trial studies (Ennis, 2015, 2017a). Sun et al. (2012) examined the effects of the SPEM on elementary students' knowledge learning about PA and fitness using a large-scale, randomized controlled experimental design. They found that students in the SPEM curriculum gained more knowledge than students in the traditional multiactivity PE curriculum ($p < .05$, Cohen d ranged from 0.97 to 2.21). Wang et al. (2017) examined middle school students' knowledge learning in SHL curriculum. They found that the students' knowledge test scores increased from an average of 37% correct responses to 61% correct responses ($p < .01$, Cohen $d = 1.41$) after one semester of learning the SHL curriculum. In addition, the preliminary analysis on the effects of SHL curriculum on middle school students' knowledge learning showed that students who studied the SHL curriculum gained more knowledge ($p < .05$, Cohen $d = 1.01$) than students in the traditional multiactivity PE curriculum.

Previous research suggests that the SHL curriculum can positively affect knowledge of physical fitness and fitness performance. What remains unclear is whether it can influence students' PA behavior outside of the school. In the current study, we focused on determining the effects of the SHL curriculum on middle school students' out-of-school PA behavior.

The SHL Curriculum

The SHL curriculum was developed to help middle school students learn the scientific knowledge about PA and fitness in an autonomy-supportive learning environment. This curriculum includes two 20-lesson units focusing on the concepts and principles about exercise and fitness and creating individual fitness/exercise plan. The curriculum includes 120 lessons in total, 40 for each grade. Table 1 shows the topic summary of these lessons for sixth grade students.

This curriculum is unique in several ways. First, each lesson in this curriculum is delivered using a learner-centered 5Es instructional system, *Engagement*, *Exploration*, *Explanation*, *Elaboration*, and *Evaluation* (Bybee et al., 2006), for students to assume the role of "Junior Scientists" in learning. For example, for an activity related to heart rate, during *Engagement* phase, the teacher involves students in an instant PA and use this activity to introduce the scientific vocabularies and concept they are going to learn. Students are asked to record their preactivity heart rate or other measures in their workbook. During *Exploration*, students are organized to investigate a variety of PAs to collect postactivity physiological and psychological responses to compare with the preactivity measures. Through prediction, experiment, observation, and documentation, students collect and study the data as directed by their workbook questions. In *Explanation*, students are guided to form small groups to "Think, Pair, Share" with their peers to interpret the data. They compare and analyze each other's data to understand the impact of PA on different bodies. In *Elaboration*, the teacher further elaborates the concepts and principles the data inform and guides the students to discuss implications of PA to life beyond PE. The teacher frequently challenges the students by asking them to create new exercises to demonstrate their understanding of the concept being studied. In *Evaluation*, students summarize the data and the knowledge learned to reach conclusions that reinforced the concept. Usually, they are prompted to answer an open-ended real-life question on their workbook summarizing the concept just learned.

Second, in this curriculum, students are required to use a workbook in each lesson. The workbook contains content closely tied to the PAs in a lesson and serves as a centerpiece of knowledge construction tool to assist learning. The assignments in the workbook are sequenced with progressive complexity from descriptive to relational and to reasoning tasks. These tasks are presented to students as questions/problems associated with the PAs being experienced to facilitate their knowledge construction.

Finally, the content, structure, and instructional system of this curriculum are designed to elicit high levels of autonomous motivation among students (Ennis, 2015). For example, several curriculum components were specifically designed to increase students' psychological needs satisfaction and subsequently increase their autonomous motivation. These elements include an emphasis on learning rationale, opportunities for decision making, advocacy of knowledge mastery rather than competition, and encouragement of cooperative peer communication.

Theoretical Framework: Two Pathways of PE Effect

As the SHL curriculum focuses on students' knowledge learning in an autonomy-supportive learning environment, the current study was guided by two theoretical models that specifically focus on how PE can influence students' out-of-school PA. The two models are the situational-to-self-initiated motivation model (Chen & Hancock, 2006) and the transcontextual model (Hagger & Chatzisarantis, 2016). The former model postulates how knowledge learning in PE influences students' out-of-school PA. The latter model provides a theoretical basis for promoting students' out-of-school PA through improving their autonomous motivation in PE.

The Situation-to-Self-Initiated Motivation Model

The basic proposition of the model is that children and adolescents' long-term PA behavior change depends on their self-initiated motivation, which is defined as "the drive to engage in an activity based on a person's self-concept system consisting of his/her perceived competence, self-efficacy, and expectancy beliefs and values in the activity" (Chen & Hancock, 2006, p. 357). Children and adolescents' PA motivation, however, tends to be situational and is often driven by the immediate appealing characteristics of the environment or activity. This situational motivation is effective to influence students' short-term PA behavior change such as those in a PE lesson but may not be sufficient to sustain the behavior change for long term (Chen & Hancock, 2006). The model suggests that for sustained behavior change, it is important to help students internalize the situational motivation into self-initiated motivation. Chen and Hancock propose that a competence-centered PE curriculum with the emphases on learning knowledge and motor skills can contribute to this internalization process and subsequently contribute to long-term PA behavior change. Based on this model, the SHL curriculum, which focuses on promoting students' knowledge learning, has the potential to influence students' PA behavior outside of the school.

Some empirical studies have shown that knowledge has a positive influence on students' PA behavior. For example, DiLorenzo, Stuky-Ropp, Vander Wal, and Gotham (1998) investigated the relationship between exercise knowledge and PA behavior. They found that eighth and ninth grade students' exercise knowledge positively predicted their PA behavior. Chen, Liu, and Schaben (2017) examined the relationship between eighth graders' PA/fitness knowledge and their PA and sedentary behavior. They found that students in high knowledge group had higher levels of out-of-school PA than those in low knowledge group. Thompson and Hannon (2012) examined the relationship between high school students' health-related fitness knowledge and their PA behavior. They found that students who scored higher on knowledge test also reported higher PA level than students who scored low on knowledge test.

The Transcontextual Model

The transcontextual model emphasizes the effects of students' motivational experience in PE on their PA behavior outside of the school (Hagger & Chatzisarantis, 2016). Specifically, this model focuses the effects of students' autonomous motivation in PE on their out-of-school PA. Autonomous motivation in this model is defined as "engaging in activities out of a sense of personal agency, for interest and satisfaction derived from the activity itself, or its concomitant outcomes, and in the absence of any externally referenced contingencies" (p. 361). The transcontextual model is supported by three basic tenets (Hagger & Chatzisarantis). The first is that students' perception of autonomy support predicts their autonomous motivation for PE. The second is that autonomous motivation for PE predicts autonomous motivation toward PA. The third basic tenet is that autonomous motivation toward PA predicts intended and actual engagement in out-of-school PA through influencing attitude, subjective norms, and perceived behavior control. The basic idea of this model is that an autonomy-supportive learning environment in PE can positively influence students' PA behavior outside of the school through influencing their autonomous motivation for PE and PA. Hagger and Chatzisarantis employed a meta-analytic path analysis to synthesize current research findings on the transcontextual model. They found that the empirical findings supported the theoretical proposition in the transcontextual model. In addition, Yli-Piipari, Layne, Hinson, and Irwin (2018) using cluster-randomized experimental design showed that positive motivational experience in PE did transfer to influence out-of-school PA.

As mentioned previously, the SHL curriculum was designed to elicit high levels of autonomous motivation among students (Ennis, 2015). Many curricular components were integrated to increase students' psychological needs satisfaction and subsequently increase their autonomous motivation. Based on the transcontextual model, this could be another important aspect of this curriculum that can positively influence students' out-of-school PA.

Purpose

The two models share two common assumptions as follows: (a) PE can play an important role on influencing students' out-of-school PA and (b) PE does not directly influence out-of-school PA; instead, it indirectly influences students' out-of-school PA through influencing their motivation for PA. In general, these two models imply two pathways by which the SHL curriculum can influence students' out-of-school PA. The first pathway is to increase student knowledge learning in PE. The second is to improve their motivational experience in PE. In addition, both models indicate that motivation for PA tends to mediate the "PE effect." To further understand the possible mechanisms of the "PE effect," the effects of SHL curriculum on knowledge about PA and fitness, autonomous motivation for PE, and autonomous motivation for PA were examined in this study. The following research question was addressed: what are the differences in levels of knowledge, autonomous motivation for PE, autonomous motivation for PA, and out-of-school PA in middle school students who experience the SHL curriculum compared with middle school students who experience a traditional multiactivity PE curriculum?

Methods

Setting and Research Design

This study adopted the static group comparison design with an experimental group (SHL condition), consisting of the students who received PE under the structure of the SHL curriculum, and a comparison group (comparison condition) who received PE under the structure of a traditional multiactivity curriculum. The static group comparison design is considered effective in studying the effects of CPE on PA behavior among high school (Dale & Corbin, 2000; Dale et al., 1998; Kulinna et al., 2018) and college students (Brynteson & Adams, 1993). Adopting this design allowed us to compare the CPE and Traditional curricular conditions for 14 months after the students experienced their respective curriculum.

The students in the experimental group experienced the SHL curriculum during their sixth grade PE program, whereas the students in the comparison group experienced the state-sanctioned PE program reflective of a traditional multiactivity curriculum during their sixth grade PE program. During their sixth grade time, their teachers received extensive professional development for the delivery of the SHL program and traditional multiactivity program. In grade seven, the students in both conditions were taught by the same teachers as in sixth grade and studied the same state-sanctioned curriculum that focused on providing students with opportunities to experience multiple forms of PAs, usually in team sports and games. During the seventh-grade lessons, cognitive knowledge about PA and fitness was not emphasized, although at times mentioned. The curriculum was usually organized into short units so that students could be exposed to broad sport-based activities which mainly included team sports and cooperative games. A typical lesson of this multiactivity PE program started with about 10–15 min of teacher-directed warm-up and fitness activities, followed by 15–25 min of skill development or scrimmage game play, and then about 5 min of lesson closure and/or cool-down activities. With progress, more instructional time was allotted to game play in these lessons. Teachers used direct instruction approach to teach the state sanctioned curriculum. The seventh grade students in both were not exposed to any other programs about PA knowledge learning or PA promotion in schools. On average, every student received five 45–50 min PE lessons per 2 weeks. The data for the current study were collected at the beginning of the students' eighth grade school year.

Participants

The participants were 394 eighth grade students. These students provided complete data sets for this study. Among this sample, 168 students (42.6%) received PE under the experimental condition (SHL curriculum) during sixth grade, and 226 students (57.4%) received PE under the control condition (Traditional Multiactivity PE curriculum). This sample consisted of 51.0% boys (n = 201) and 49.0% girls (n = 193). The ethnicity composition of this sample was as follows: 30.5% Hispanic (n = 120), 25.6% Black (n = 101),24.6% White (n = 97), 5.3% Asian/Pacific Islander (n = 21), 0.8% American Indian (n = 3), 0.5% Arabic American (n = 2), and 12.7% mixed race (n = 50). This study was approved by the University of North Carolina-Greensboro institutional review board and the research committee of the school districts in which these five schools were located. All participants returned the signed parent/guardian consent form and student assent form.

Variables and Measures

Autonomous motivation toward PA.—Behavioral Regulation in Exercise Questionnaire (BREQ) was used to measure autonomous motivation toward PA (Owen, Smith, Lubans, Ng, & Lonsdale, 2014). This questionnaire includes 15 items measuring four motivational regulations as follows: intrinsic motivation (4 items; e.g., I exercise because it is fun), identified regulation (4 items; e.g., I value the benefits of exercise), introjected regulation (3 items; e.g., I feel guilty when I do not exercise), and external regulation (4 items; e.g., I exercise because other people say I should). Each item is scored using a 5-point Likert-type scale ranging from 0 (not true for me) to 4 (very true for me). This scale has demonstrated satisfactory internal consistency reliability (α = .65–.93) and construct validity when used to measure adolescents' autonomous motivation toward PA (Hagger et al., 2009).

The BREQ scores were converted into one composite score named as the relative autonomy index (RAI) to represents students' autonomous motivation for PA (Vallerand, 1997). RAI for PA was calculated using the following formula: RAI = 2 × intrinsic motivation + 1 × Identified regulation − 1 × Introjected regulation − 2 × External regulation (Hagger et al., 2009).

Out-of-school PA.—Students' out-of-school PA was operationalized as the time students spent in exercising during the out-of-school hours. It was measured using the modified Three-Day Physical Activity Recall (3DPAR) survey (Weston, Petosa, & Pate, 1997). This survey asks for the types of PA and time that participants engaged in during their out-of-school hours. This instrument demonstrated strong evidence for test–retest reliability (r = .98) and construct validity (r = .77 with accelerometers) in adolescents (Weston et al., 1997). The 3DPAR has often been used to measure students' out-of-school PA in recent years (e.g., Chen, Sun, Zhu, & Chen, 2014).

Autonomous motivation for PE.—Autonomous motivation for PE was measured using the revised Perceived Locus of Causality Scale (PLOCS; Vlachopoulos, Katartzi, Kontou, Moustaka, & Goudas, 2011). It includes 15 items, measuring four motivational regulation subscales as follows: intrinsic motivation (4 items; e.g., I participate in PE because PE is enjoyable), identified regulation (4 items; e.g., I participate in PE because it is important to me to do well in PE), introjected regulation (4 items; e.g., I participate in PE because I would feel bad if the teacher thought I am not good at PE), and external regulation (3 items; e.g., I participate in PE because in this way I will not get a low grade). Each item was scored using a 7-point Likert-type scale ranging from 0 (*not at all true for me*) to 6 (*absolutely true for me*). The revised PLOCS has demonstrated good construct validity and reliability in children and adolescents (Vlachopoulos et al., 2011).

RAI was used to represent students' autonomous motivation for PE. The RAI was calculated using the following formula: RAI = 2 × Intrinsic motivation + 1 × Identified regulation − 1 × Introjected regulation − 2 × External regulation.

Knowledge about PA and fitness.—Students' knowledge about PA and fitness was measured using a 25-item, multiple-choice knowledge test. This test measured the following knowledge domains: concepts about PA (intensity and duration) and health-related fitness (cardiorespiratory fitness), exercise principles (principles of overload), PA recommendations, and self-management concepts (SMART goal). These items were selected from the knowledge question bank validated during the SHL project (Ennis, 2015). The following describes the validation process for each item.

Each question item was reviewed and determined by exercise physiologists and PE experts (*n* = 7) for content accuracy. All the experts were associates or full professors and have published 10 or more research articles in their field. All experts rated each question item on a 5-point scale to indicate the knowledge accuracy (1 = *inaccurate*; 5 = *accurate*) and language appropriateness (1 = *inappropriate*; 5 = *appropriate*). Question items that were rated below 5 by one or more experts were discussed, revised, and rated again. Only question items that were score as 5 by all experts were entered the question bank for field testing. The field test was conducted in a group of students (*n* = 330) not included in this study. Only question items that showed a difficulty index of .45–.65 and discrimination index larger than .40 were remained in the question bank as the validated question items.

Data Collection

All data were collected in classrooms or a quiet area of the gymnasium following a planned sequence. First, PLOCS and BREQ were administered together in one PE class session. Then, the knowledge test was administered in another PE class session. This sequence was purposely arranged so that students' response to the motivation scales would not be affected by the questions in the knowledge test. To control for possible confounding effects, the counter-balanced sequence strategy was used in administering the two motivation scales (PLOCS and BREQ). It took the students about 20 min to complete these two instruments. The 3DPAR surveys were administered during the next 2 weeks. Daily out-of-school PA recall was administered three times for students to record out-of-school activities for 2 weekdays and 1 weekend day (Sunday in this study). The participants were instructed on how to document and recall their out-of-school activities. All student questions were addressed immediately during data collection.

Data Analysis

A MANOVA was conducted with curricula (SHL vs. Traditional) as the independent variable and knowledge, autonomous motivation for PE, and autonomous motivation toward PA as the dependent variables. Because out-of-school PA was not normally distributed, the Mann–Whitney *U* test was conducted with curricula as the independent variable and out-of-school PA as the dependent variable.

To determine the unit of analysis in this study, the intracorrelation coefficients for each dependent variable were calculated using the following formula: $\rho = (MS_b - MS_w)/(MS_b + [n - 1]\, MS_w)$ with ρ referring to intracorrelation coefficient, MS_b between-group mean square, MS_w within-group mean square, *n* number of observations in each group (Chen & Zhu, 2001). The intracorrelation coefficient for knowledge was .285, autonomous motivation toward PA .018, autonomous motivation for PE −.005, and out-of-school PA .009. Chen and Zhu (2001) have recommended that when the intracorrelation coefficient is <.10, the assumption of independent observation can be considered met, and individual scores may be used for analysis. When the intracoefficient is larger than .10, the assumption is violated; adjustment in the subsequent analysis is needed. In that instance, two strategies can be used for data analysis as follows: (a) using the group means as the unit of analysis or (b) using individual scores with an adjusted α level to at least 10 times smaller than the intended *p* value (Chen & Zhu, 2001).

In this study, we adopted the individual scores as the unit of analysis to keep the analyses consistent with all dependent variables for consistent result interpretation. Because the intracorrelation coefficients for autonomous motivation for PE, autonomous motivation toward PA, and out-of-school PA were <.10, the α levels for these three variables were set as .05. As the intracorrelation coefficient for knowledge was larger than .10, the α level for this variable was set as .005. All tests were conducted using SPSS (version 25; IBM, Armonk, NY).

Results

Table 2 shows the descriptive statistics of the four dependent variables. Students who experienced the SHL curriculum demonstrated a higher mean knowledge score than students who experienced the Traditional Multiactivity curriculum. They also had higher mean scores on autonomous motivation for PE, autonomous motivation for PA, and out-of-school PA than students who experienced the Traditional Multiactivity curriculum.

Before conducting the MANOVA, distribution normality assumption was examined. As shown in Table 2, the variable of out-of-school PA had the highest skewness index that was around1.20. The highly positively skewed distribution of out-of-school PA indicates that a nonparametric test would be better for this variable than the conventional *t* or *F* test (Howell, 2013). As the independent variable had two levels, the Mann–Whitney *U* test was used to determine the difference between the two groups (SHL and Traditional). Because the distributions of the other three dependent variables were approximately normal, MANOVA was conducted for these three variables.

MANOVA Test Results

The Box *M* test was conducted to test the homogeneity assumption of the covariance matrices. The results showed a Box *M* value of13.42 with a *p* value of .038, which was interpreted as nonsignificant based on Huberty and Petoskey's (2000) guideline (i.e., $p > .005$). Thus, the covariance matrices between the two groups were assumed to be equal for the purpose of MANOVA. A statistically significant MANOVA effect was obtained, Pillai's Trace = .15, $F(3, 390) = 23.04$, $p < .001$. The multivariate effect size (η^2) was .15, which implies that 15% of the variance in the canonically derived dependent variable was accounted for by the group condition.

Before conducting the follow-up univariate analysis, the homogeneity of variance assumption was tested for the three dependent variables. Based on the results of the Levene *F* tests, the homogeneity of variance assumption was considered satisfied, even though two of the three Levene *F* tests were statistically significant ($p < .05$). Specifically, although the Levene *F* test suggested that the variances associated with knowledge and autonomous motivation toward PA were not homogenous, an examination of the SDs (see Table 2) revealed that none of the larger SDs were more than four times the size of the corresponding smaller ones, suggesting that the univariate analysis would be robust in this case (Howell, 2013).

Three one-way ANOVAs were conducted as follow-up tests to the MANOVA. The results showed a significant difference between the SHL and the Traditional Multiactivity curricular groups for knowledge ($F = 68.91$, $df = 1$, $p < .001$, $\eta^2 = .15$) and autonomous motivation toward PA ($F = 4.10$, $df = 1$, $p < .05$, $\eta^2 = .01$), and a nonsignificant difference for autonomous motivation for PE. The Cohen *d* effect sizes showed that the effect size was large (Cohen $d = .81$) for knowledge and small for autonomous motivation toward PA (Cohen $d = .20$).

The Mann–Whitney *U* Test Results

Since out-of-school PA was not normally distributed, other related descriptive statistics were reported in Table 2. The Mann–Whitney *U* test showed that students who experienced the SHL curriculum spent more time than students experiencing the Traditional Multiactivity curriculum on PA during out-of-school hours (Mann– Whitney $U = 16677.50$, $Z = -2.07$, $p < .05$). The mean ranks and the sum of ranks are 211.23 and 35486.50 for the SHL group, 187.29 and 42328.50 for the Traditional Multiactivity group. To calculate effect sizes, the following formula was used as suggested by Field (2009): $r = \text{abs}(Z/\sqrt{N})$. The effect size for out-of-school PA was 0.01, which is considered as a small effect size (Field, 2009).

Discussion

The purpose of this study was to determine the effects of the SHL curriculum on middle school students' knowledge, autonomous motivation toward PE, autonomous motivation toward PA, and out-of-school PA in comparison with a Traditional PE Multiactivity curriculum. The results of this study showed that students who had experienced the SHL curriculum had higher levels of knowledge, autonomous motivation toward PA, and out-of-school PA than students who had only experienced the Traditional Multictivity PE curriculum during middle school. Students in both curricula were equally motivated for their respective experiences in PE as shown by their average score on autonomous motivation toward PE.

It is important to acknowledge that this study is a 14-month follow-up study of the SHL curriculum intervention research. Participants in this study came from the schools that were randomly assigned to the experimental or comparison groups during the research. Participants in the experimental group studied the SHL curriculum only for a year when they were at the sixth grade, whereas participants in the comparison group of this study had experienced the Traditional Multiactivity PE for their 3-year tenure during middle school.

PA and Fitness Knowledge: Curriculum Matters

The data from this study demonstrated that the students who experienced the SHL curriculum had a significantly higher knowledge than students who experienced the Traditional Multiactivity PE curriculum (Cohen $d = 0.81$) after a year interval. Because of the research design of the original study (groups of sixth graders experiencing different PE curricula), the knowledge data were not collected from students (the last cohort of the original intervention study) in the Traditional Multiactivity curriculum group. Thus, we are unable to determine the size of knowledge difference between the two groups in this study immediately before and after the implementation of SHL intervention. Since the cohort in this study and previous cohorts from the same schools were taught the same content in the same way by the same PE teachers and both groups of students were taking the similar multi-activity PE curriculum, in which knowledge about PA and fitness was not emphasized during the 14-month interval, it is reasonable to speculate that the higher knowledge level of the students in the SHL curriculum group than the students in the Traditional Multiactivity curriculum group in this study is the result of the SHL curriculum. This suggests that the knowledge advantage gained from learning the SHL curriculum can last at least 14 months.

This sustained knowledge learning effect may derive from the constructivist-oriented curriculum and the instructional components built into the curriculum (Zhang et al., 2014). These components include connecting cognitive knowledge learning with PA experiences to make the learning meaningful, building new knowledge on prior knowledge to develop personalized knowledge structure, adopting the 5E instructional structure to scaffold the learning experiences, incorporating the workbook in every lesson to facilitate cognitive engagement, and imbedding organized student–student social interactions (e.g., think–pair–share) to create effective learning communities (see Zhang et al., 2014). According to the constructivist learning theory, these components can help students develop solid and deep understanding about the concepts and principles learned in the lessons (Alexander, 2006). Knowledge that is deeply understood and integrated into existing knowledge structure is more likely to be retained for a long time (Ausubel, 2000).

It is important to acknowledge that students in the SHL group of the current study had only experienced 1 year of the SHL curriculum that was designed for sixth graders. The SHL curriculum includes a 20-lesson unit for each grade to teach and reinforces the knowledge about PA and fitness (Ennis, 2015). The content of the curriculum was sequenced using the spiral sequencing structure to ensure solid and deep knowledge learning through repeatedly visiting and revisiting the key facts, concepts, and principles across different lessons and grades (Ennis, 2015). Based on the previously mentioned findings , it is plausible to conclude that the SHL curriculum works in developing and enhancing middle school students' knowledge about PA and fitness during the learning experience and long after the learning experience is over.

Out-of-School PA: Curriculum Matters

Another important finding is that students who experienced the SHL curriculum spent more time on PA during out-of-school hours than students who had only experienced the Traditional PE curriculum. This finding suggests the critical role of the PE curriculum on developing middle school students' out-of-school PA behavior. Sun et al. (2012) have provided strong evidence that curriculum matters in PE to increase students' knowledge learning. The findings of the current study imply that curriculum in PE matters not only in improving students' knowledge learning but also in promoting their out-of-school PA behavior.

The findings may be attributed to the teaching approach used in the SHL group which focuses on knowledge learning. Conceptual learning is believed to be able to drive peoples' behavior or behavior change (von Glasersfeld, 1995). It is argued that conceptual understanding of PA and fitness has the potential to impact and change students' decision-making process about being physically active and consequently influence their PA behavior (Ennis, 2007). Previous studies did show some positive relationship between knowledge and PA behavior. For example, Chen, Liu, and Schaben (2017) reported that students who were in the high knowledge group had higher level of out-of-school PA than students who were in low knowledge group. In addition, Dale and colleagues examined the effects of the Fitness for Life curriculum on high school students' PA and sedentary behavior (Dale & Corbin, 2000; Dale et al., 1998). Although knowledge scores were not examined in their studies, they found that more male students in the Fitness for Life group reported being physically active than those in the traditional PE group and fewer female students in the Fitness for Life group were categorized as being sedentary than in the traditional PE group.

Knowledge, Motivation for PA, and Out-of-School PA

According to the situational-to-self-initiated motivation model, knowledge learning in PE can influence students' out-of-school PA through influencing their motivation toward PA (Chen & Hancock, 2006). In this study, we found that students in the SHL group had not only significantly higher knowledge scores but also significantly higher scores on autonomous motivation toward PA than students in the traditional PE group. According to the situational-to-self-initiated motivation model, it is plausible to argue that the reason that students in the SHL group had higher levels of out-of-school PA than students in the Traditional PE group is perhaps because they possessed more knowledge about PA and fitness, which enabled them to have higher levels of motivation toward PA. The higher motivation level toward PA resulted in the higher out-of-school PA level of students in the SHL group than those in the Traditional PE group. Further studies are needed to testify this explanation using stringent experimental design.

Effects on Autonomous Motivation for PE

In this study, no significant difference was found between students in the SHL group and those in the Traditional PE group in terms of autonomous motivation for PE. The SHL curriculum in this study was designed to elicit high levels of autonomous motivation among students, such as the emphasis on learning rationale, opportunities for making task choice, advocacy of mastery rather than competition, and encouragement of cooperative peer communication (Ennis, 2015; Sun et al., 2012). These components have been shown to be effective instructional strategies to increase students' autonomous motivation (Wang, 2017).

The nonsignificant difference between the two groups may derive from two possible reasons. The first reason could be that students' autonomous motivation for PE only reflects their motivational experience in the current PE curriculum. At the time of data collection, students in the SHL group had been taking the Traditional Multiactivity PE curriculum for about 14 months. Both groups of the students were receiving PE under the same curricular format at the time of data collection. The second reason could be that the motivational benefits from the SHL curriculum did not endure 14 months later. Su and Reeve (2011) summarized that effective autonomy-supportive teacher interventions should be comprehensive, prolonged, skill-oriented, and multifaceted in training format. They also suggested that to make the intervention benefits endure, supplemental follow-up activities should be included in the intervention. Although the SHL curriculum incorporated motivation strategies in the design (situational interest, self-determination, and expectancy-value components), it was not meant to be a motivation intervention curriculum. In other words, the SHL curriculum did not target promoting students' autonomous motivation in PE. There were also no autonomous motivation-focused follow-up activities included in the curriculum intervention. These situations may result in the nonsignificant difference between the two groups for autonomous motivation for PE. As this study focused on the 14-month delayed differences between students who studied SHL curriculum and the Traditional PE curriculum, future studies should examine the immediate effects of the SHL curriculum on students' autonomous motivation for PE.

Strengths and Limitations

A strength of this study appears to be the focus on examining the latent long-term comparison on knowledge learning, PA motivation, and behavior between students who studies SHL and Traditional PE. This study is one of only a few to document the potential long-term impact of PE. The findings add important evidence to the literature suggesting that SHL curriculum may have a long-lasting effect on students after they leave PE. Indirectly, the findings suggest that knowledge is the basis for behavior development and modification. One limitation of the study could be the administration of the BREQ and PLOCS scale on the same day due to challenging school schedules. It is suggested that it would be more appropriate to administer these two instruments on different days due to the similar constructs they are measuring. To minimize the impact of this limitation, we specifically reminded students to pay attention to the subject (PE vs. exercise) these scales focus on during the data collection. We believe that the threats to data reliability were controlled as we carefully implemented the data collection plan. It is important for readers to keep in mind that the conclusion of this study is based on the static group comparison design because of the lack of pretest data. To minimize the impact of this limitation, we based our group comparison design on the randomized controlled design of the original research. Because the schools in this study were randomly assigned to the SHL and Traditional groups originally, we believe that this randomized assignment can still work, to some extent, which maintained appropriate rigor for this study. Future studies should use experimental design to further confirm the findings of this study.

Conclusion

This study examined the effect of the SHL curriculum on middle school students' knowledge, out-of-school PA, and autonomous motivation for PE and PA. The results indicate that students who have experienced the SHL curriculum had higher levels of knowledge about physical activity and fitness, autonomous motivation toward PA, and out-of-school PA than students who had only experienced the traditional multiactivity PE curriculum. This study implies that a concept-based PE curriculum is effective to increase students' knowledge gain and the knowledge advantage obtained sustains 14 months later after the intervention. More importantly, this study indicates that a concept-based PE approach may be an effective curriculum model to promote students' PA behavior outside of the school.

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Table 1

Table of Contents of the Science of Healthful Living Curriculum for Sixth Grade

Lesson	Topic
1	Measuring Heart Rate
2	Intensity - Rating of Perceived Exertion (RPE)
3	Introduction to Exercise Intensity
4	Short- and Long-term Benefits of Physical Activity
5	Introduction to Exercise Type
6	Introduction to Fitness Components
7	Comparing Muscular Strength and Endurance
8	Introduction to Flexibility
9	Introduction to Frequency
10	Introduction to Time
11	Measuring Intensity
12	Introduction to the Principle of Overload
13	Introduction to the Principle of Progression
14	Introduction to the Principle of Progressive Overload
15	Introduction to the Principle of Specificity
16	Characteristics of Anaerobic Exercise
17	Introduction to the Anaerobic Energy Systems
18	Characteristics of Aerobic Exercise
19	Introduction to SMART Goal Strategies
20	Applying SMART Goal Strategies to the Principle of Progressive Overload

Table 2

Descriptive Statistics for All Variables

	Total		SHL curriculum		Traditional curriculum	
Variable	**Mean /SD**	**Skew**	**Mean/SD**	**Skew**	**Mean/SD**	**Skew**
Knowledge	0.41/0.17	0.46	0.48/0.18	0.12	0.35/0.14	0.57
RAI-PE	2.47/5.27	0.47	2.61/5.23	0.23	2.37/5.30	0.64
RAI-PA	4.07/3.24	0.02	4.44/2.96	−0.23	3.79/3.42	0.21
OS-PA	71.54/63.39	1.18	77.60/64.00	1.17	67.07/62.70	1.21
	Median	Max./Min.	Median	Max./Min.	Median	Max./Min.
OS-PA	60	335/0	70	335/0	50	305/0

Note. Skew = skewness; PA = physical activity; PE = physical education; OS-PA = out-of-school PA (min/day); RAI-PE = relative autonomy index for PE; RAI-PA = relative autonomy index for PA; Max. = maximum; Min. = minimum; SHL = Science of Healthful Living.