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Two Pathways Underlying the Effects of Physical Education on Out-of-School Physical Activity

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ABSTRACT
One primary goal of physical education (PE) is to promote students’ lifelong physical activity (PA). This goal implies that PE should not only improve students’ PA in PE classes but also promote their PA outside of the school known as the “PE effect.” Purpose: In this study, we proposed a two-pathway model of the “PE effect” and hypothesized that learning in PE and positive motivational experience in PE are two possible pathways through which the “PE effect” emerges. We tested the tenability of this two-pathway model from the perspective of knowledge learning and autonomous motivation in PE. Methods: A total of 394 eighth-grade students from five schools provided data on PA knowledge, out-of-school PA, and autonomous motivation toward PE and PA. Structural equation modeling was used to test the two-pathway model. Results: Results showed that the students’ knowledge had a direct effect (β = .18, p < .05) on their autonomous motivation for PA and an indirect effect (β = .02, p < .05) on out-of-school PA through influencing autonomous motivation toward PA. Students’ autonomous motivation for PE had a direct effect (β = .41, p < .05) on their autonomous motivation toward PA and an indirect effect (β = .04, p < .05) on out-of-school PA through autonomous motivation toward PA. Conclusion: These results indicate that the two-pathway model is tenable in terms of knowledge learning and autonomous motivation in PE and imply that teaching knowledge in an autonomy-supportive PE environment may be an effective way to promote students’ out-of-school PA.

One primary goal of physical education (PE) is to promote students’ lifelong physical activity (Corbin, 2002; Ennis, 2017). This goal implies that PE should not only improve students’ in-class physical activity (PA) behavior but also promote their PA behavior outside of the school. Green (2014) refers to the impact on out-of-school PA as the “PE effect” (p. 357). The “PE effect” is frequently cited by PE teachers and scholars and is often included in government policies across the world. Despite the wide citations of the “PE effect”, there is little research evidence documenting the “PE effect” due to the limited research on the connection between PE and out-of-school PA behavior.

To achieve the “PE effect”, one critical step is to understand the underlying mechanisms. To understand the mechanisms, we need to be addressed. The first is to identify key factors in PE that contribute to out-of-school PA behavior. The second is to understand the way these factors function (e.g., direct effect or indirect effect). In this study, we proposed a two-pathway model of the “PE effect”, as a priori, by synthesizing two existing theoretical models. We then set out to test the tenability of this two-pathway model.

A two-pathway model of the “PE effect”

There seem to be different perspectives on achieving the “PE effect.” Ennis (2017) proposed the concept of “Transformative PE” (p. 1) to promote lifelong PA. She argued for a focused transformative PE to target students’ cognitive knowledge, self-motivation, and personal meaning about PA. Penney and Jess (2004), however, proposed to broaden the scope of PE curricula to include functional PA, recreational PA, health-related PA, and performance-related PA. Corbin (2002), on the other hand, emphasized the needs for independent and self-directed behavior adaptation and suggests that PE should focus on self-management knowledge (e.g., goal setting) and problem-solving skills (e.g., how to assess fitness) along with the activities.

The diverse perspectives reflect that theoretical models focusing on the “PE effect” mechanisms are rare. In our literature search, we found two such models. One model is Chen and Hancock (2006) situational-to-self-initiated motivation model. The other is the Hagger and Chatzisarantis (2016) trans-contextual model.
The situational-to-self-initiated motivation model

The situational-to-self-initiated motivation model (Chen & Hancock, 2006) proposes that children and adolescents’ PA motivation tends to be situational and depends on the immediate appealing characteristics of an environment or activity. This situational motivation is effective in changing PA behavior for a short period such as those in a PE lesson, but not enough for long-term behavior change. The key for long-term or sustained behavior change relies on 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). Internalizing situational motivation into self-initiated motivation depends on the nature of the PE curriculum. Chen and Hancock (2006) believe a competence-centered PE curriculum with emphases on learning knowledge and motor skills can contribute to this internalization process.

A stage of change model is the hypothesized mechanisms for the situational-to-self-initiated motivation internalization process. Drawing from the stages of domain learning, Chen and Hancock (2006) suggested that adolescents’ PA behavior change is a process involving progress through three stages: acclimation, competence, and proficiency. Adolescents can be categorized into one of these three stages based on their knowledge, self-conceptions, and motivation sources.

In this model, the PE curriculum plays a pivotal role during the motivation and behavior change process. It is a vehicle that guides and carries adolescents to progress through these motivational and behavioral change stages. For example, PE can help adolescents who can only be motivated to exercise with peers (situationally motivated) become motivated to exercise on their own (self-motivated) once having learned strategies to apply effective knowledge and skills.

Chen and Hancock (2006) also suggested that community variables, such as community resources and safety, can influence the process of adolescents’ motivational and behavioral change. An effective PE curriculum may reinforce the positive effects and constrain or reduce the negative effects of community variables on adolescents’ motivation and behavior change.

The trans-contextual model

The trans-contextual model (Hagger & Chatzisarantis, 2016) explains how students’ autonomous motivation for PE impacts their PA behavior in the out-of-school context. It integrates the theoretical tenets of self-determination theory (Deci & Ryan, 2000), hierarchical model of intrinsic and extrinsic motivation (Vallerand, 1997), and the theory of planned behavior (Ajzen, 1991). 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” (Hagger & Chatzisarantis, 2016, p. 361). Three forms of autonomous motivation were proposed in this model, intrinsic motivation, integrated regulation, and identified regulation, to contrast with two forms of controlled motivation—introjected regulation and external regulation.

The trans-contextual model is supported by three basic tenets (Hagger & Chatzisarantis, 2012). 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 influences attitude, subjective norms, and perceived behavior control, which in turn impact PA intention and eventually PA behavior. Hagger et al. (2009) tested the trans-contextual model using a three-wave prospective design in samples from four European nations. They found that the central propositions of the trans-context model were supported in samples of all four nations. González-Cutre, Sicilia, Beas-Jiménez, and Hagger (2014) using the same design confirmed the tenability of the central propositions of the trans-contextual model in Spanish adolescents. In addition, using a cluster-randomized experimental design Yli-Piipari, Layne, Hinson, and Irwin (2018) showed that positive motivational experience in PE did transfer to influence out-of-school PA.

Integrating the two models

The two models share one common assumption. That is, PE is central to students’ out-of-school PA behavior. The situational-to-self-initiated motivation model (Chen & Hancock, 2006) suggests that effective learning in PE can facilitate adolescents’ transition from situational motivation to self-initiated motivation, which subsequently can lead to long-term PA behavior change. The trans-contextual model (Hagger & Chatzisarantis, 2016) proposes that autonomous motivation experienced in PE can be transferred to autonomous motivation toward PA, which in turn can influence PA behavior outside school. The two models imply two pathways by which PE can influence students’ out-of-school PA. The first pathway is...
through influencing students’ learning in PE; the second is through influencing their motivational experience in PE.

Another common assumption of these two models is that PE may not directly influence out-of-school PA behavior. Instead, it contributes to out-of-school PA behavior through influencing students’ PA motivation. In other words, the effects of students’ learning and motivation in PE on out-of-school PA tend to be mediated by their motivation toward PA. Consistent with this assumption, we propose a two-pathway model in Figure 1 to explain how PE can contribute to out-of-school PA behavior. We conceptualize this a priori model as a general conceptual framework of the “PE effect”. Testing this model is an initial attempt to identify possible pathways through which the “PE effect” may emerge. Our intention is to establish an initial model that allows mediators and moderators that emerge in the situational-to-self-initiated motivation model and the trans-contextual model to be integrated in future research studies.

Currently, most studies examining the “PE effect” were based on the trans-contextual model and focused on examining the pathway of motivational experience in PE (Hagger & Chatzisarantis, 2016). Little evidence is available to identify the pathway of learning in PE to achieving the “PE effect”. Examining these two pathways simultaneously can be a plausible way to further our understanding about the “PE effect”. The purpose of this study was to identify and verify the two pathways simultaneously to determine the tenability of this two-pathway model of the “PE effect”.

The present study

Learning in PE is multidimensional, generally including three dimensions—knowledge acquisition, motor skill development, and affective character cultivation (e.g., confidence, attitude). As illustrated in the situational-to-self-initiated motivation model, knowledge and skill learning in PE could be the sub-pathways through which PE impacts out-of-school PA (Chen & Hancock, 2006). In this study, for the pathway of learning in PE, we focused on students’ knowledge learning about PA and fitness.

Knowledge about PA and fitness derives from many domains that are generally referred to as health-related fitness knowledge. Keating et al. (2009) defined health-related fitness knowledge as “knowledge about individuals’ ability to perform PA and protect themselves from chronic disease” (p. 335). Zhu, Safrit, and Cohen (1999) have included a broad range of domains in this body of knowledge including concepts of fitness, scientific principles, components of physical fitness, effects of exercises on health, exercise prescription, nutrition, and injury prevention. In this study, the knowledge domains we focused on include concepts about PA (e.g., intensity, duration) and health-related fitness (e.g., cardiorespiratory fitness), exercise principles (e.g., principles of overload), PA recommendations, and self-management concepts about PA (e.g., SMART goal).

Research findings on the relationship between knowledge and PA behavior are mixed (e.g., Chen, Sun, Zhu, & Chen, 2014; Erwin & Castelli, 2008). Some studies showed that students who had high levels of knowledge had higher levels of PA than students who had low knowledge level (e.g., Chen, Liu, & Schaben, 2017). Other studies suggested that knowledge about PA did not have significant predictive effects on PA behavior (e.g., Chen et al., 2014; Erwin & Castelli, 2008). Most of these studies hypothesized and tested the direct relationship between knowledge and PA. Few of them involved testing mediating factors between knowledge and PA behavior. As the two-pathway model suggests, knowledge learning in PE tends to influence students’ out-of-school PA indirectly through motivation toward PA. We hypothesized that students’ knowledge about PA would positively influence their motivation toward PA. We believe that knowing the concepts about PA and health-related fitness, principles about how to assess health-related fitness and design a PA plan, and strategies about self-management can increase students’ perceived competence for PA, which

![Figure 1](https://example.com/figure1.png)

*Figure 1.* The a priori path model. Solid lines signify direct positive paths; broken lines indirect positive paths. PE: Physical education; PA: Physical activity.
subsequently can positively increase their motivation toward PA (Deci & Ryan, 2000). In addition, we believe that knowing the health benefits of PA which serve as a strong rationale for PA, can increase students’ perceived autonomy for PA participation, which subsequently can also increase their motivation toward PA (Reeve, 2009). It is not clear in the literature, however, about the ways that the knowledge—motivation—behavior pathways would work. This directional hypothesis would allow us to test direct and/or indirect effects of knowledge on out-of-school PA. We believe that the results will further our understanding of the relationship.

Students’ motivation for PE has been studied from many theoretical perspectives. The prominent theories that have guided most motivation research in PE include self-determination theory, expectancy-value theory, achievement goal theory, self-efficacy theory, and interest theory. In this study, for the pathway of motivation in PE, we focused on the construct of autonomous motivation, which has been theorized as contributing to student motivation for PA outside of the school (Hagger & Chatzisarantis, 2016).

Most studies examining the direct and indirect effects of autonomous motivation for PE on out-of-school PA indicate that there is an indirect effect but no direct effect of autonomous motivation for PE on out-of-school PA (e.g., Hagger et al., 2009). Several variables have been found to be significant mediators of the effects of autonomous motivation for PE on out-of-school PA. It includes autonomous motivation toward PA, attitude toward PA, subjective norm, perceived behavior control, and PA intention, enjoyment in PE, and PA level in PE. In this study, we focused on the mediator of autonomous motivation toward PA, since it was the most widely examined mediator in previous studies. To further confirm previous findings, both direct and indirect effects were identified and tested in this study.

In this study we addressed the following specific research question: to what extent did eighth-grade students’ knowledge about PA and autonomous motivation for PE contribute to their autonomous motivation toward PA and, subsequently, influence their out-of-school PA? We hypothesized that students’ knowledge and autonomous motivation for PE would not directly influence out-of-school PA. Instead, they would indirectly influence out-of-school PA behavior through influencing students’ autonomous motivation toward PA. To answer the research question, we tested the *a priori* path model (Figure 1) empirically to identify and verify the hypothesized pathways among these four variables.

**Methods**

**The research context and participants**

This study was conducted in five middle schools in a southwestern state of the United States. Students in three of the five schools received a knowledge-intensive PE curriculum the year before this study and were currently studying the traditional, multi-activity PE curriculum. Students in other two schools were only studying the multi-activity curriculum during the middle-school years. The rationale of including these two types of schools is that knowledge → autonomous motivation toward PA → out-of-school PA is one pathway to be tested in this study. Knowledge learning is usually not emphasized in the traditional, multi-activity PE (Ennis, 2010). Students learning in the traditional, multi-activity PE tend to demonstrate low level of knowledge about PA and fitness in comparison with those learning in the concept-based PE (Sun, Chen, Zhu, & Ennis, 2012). Pooling the data from the two groups together ensured enough variability of the knowledge measures so that the tenability of the knowledge pathway in the *a priori* path model in Figure 1 could be tested with adequate statistical power.

A typical lesson of the multi-activity curriculum started with about 10 to 15 min of teacher-directed warm-up and fitness activities, then about 15 to 25 min of skill development or scrimmage gameplay, and then about 5 min of closure and/or cool-down activities. With the progress of the unit, more class time was spent on playing games.

A total of 394 eighth-grade students from 30 classes of five schools provided complete data sets for this study. It included 51.0% boys (n = 201) and 49.0% girls (n = 193). The ethnicity composition of this sample was that 24.6% students (n = 97) were White, 25.6% Black (n = 101), 30.5% Hispanic (n = 120), 21 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 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**

Autonomous motivation for PA was measured using the Behavioral Regulation in Exercise Questionnaire (BREQ) (Wilson, Rodgers, & Fraser, 2002). The term “exercise” was explained at the top of the questionnaire to inform the students that exercise in this questionnaire refers to any structured and unstructured physical
activities. The BREQ scores were converted into one composite score named as the relative autonomy index (RAI) to represent students’ autonomous motivation for PA (Vallerand, 1997).

BREQ includes 15 items measuring intrinsic motivation (four items, e.g., I exercise because it is fun), identified regulation (four items, e.g., I value the benefits of exercise), introjected regulation (three items, e.g., I feel guilty when I do not exercise), and external regulation (four 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; Wilson et al., 2002).

The composite score of RAI for PA has been used to represent autonomous motivation toward PA (e.g., Hagger et al., 2009). RAI for PA was calculated based on the BREQ scores using this 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 PA 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 students for the types and time duration of PA during out-of-school hours. This instrument demonstrated strong evidence for test–retest reliability (r = .98) and concurrent validity (r = .77 with accelerometers) in adolescents (Weston et al., 1997). The 3DPAR has been used to measure students’ out-of-school PA in recent years (e.g., Chen et al., 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). The 15-item scale measures intrinsic motivation (4 items, e.g., I participate in physical education because physical education is enjoyable), identified regulation (4 items, e.g., I participate in physical education because it is important to me to do well in physical education), introjected regulation (4 items, e.g., I participate in physical education because I would feel bad if the teacher thought I am not good at physical education), and external regulation (3 items, e.g., I participate in physical education 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 plausible construct validity and reliability in children and adolescents (Vlachopoulos et al., 2011).

Relative autonomy index (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. The knowledge domains measured include concepts about PA (e.g., intensity, duration) and health-related fitness (e.g., cardiorespiratory fitness), exercise principles (e.g., principles of overload), PA recommendations, and self-management concepts (e.g., SMART goal). These items were selected from a knowledge question bank validated during the Science of Healthful Living 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 associate or full professors from departments of kinesiology and had published 10 more 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. Questions that achieved a score of five by all experts were entered the question bank for field-testing. The field test was conducted in a group of students (n = 330) for further item–analysis. Questions with a difficulty index between .45-.65 and discrimination index greater than .40 were kept in the question bank for use.

Data collection
Data were collected by the researchers in person. PE teachers assisted in class organizations. A planned sequence was followed to minimize threats to data reliability and data contamination. PLOCS and BREQ were administered first in one PE class session. A counter-balanced sequence was used to control for possible confounding of administering the two motivation scales (PLOCS and BREQ). 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. The Three-Day
Physical Activity Recall (3DPAR) surveys were administered during the next 2 weeks. Daily out-of-school PA recall was conducted three times during the 2 weeks for the students to record out-of-school activities on two weekdays and one weekend day (Sunday in this study). Prior to data collection, the students were instructed and practiced on how to document and recall their out-of-school activities. Students’ questions were addressed immediately during the data collection by the researchers.

Data analysis
To determine whether multi-level analysis is needed, the intra-class correlations (ICC) of all variables were calculated at the class and school level using the following formula: \( \rho = (\text{MS}_b - \text{MS}_w)/(\text{MS}_b + (n-1)\text{MS}_w) \) (\( \rho \) refers to intra-correlation coefficient; \( \text{MS}_b \) is between-group mean square; \( \text{MS}_w \) is within-group mean square; \( n \) is number of groups) (Chen & Zhu, 2001). The class-level ICCs for knowledge, autonomous motivation for PE, autonomous motivation for PA, and out-of-school PA were .093, .017, .023, and .003, respectively. The school-level ICCs for knowledge, autonomous motivation for PE, autonomous motivation for PA, and out-of-school PA were .285, .005, .018, and .009, respectively. Huijtsma, Mclean, and Mcknight (1999) have recommended that when the ICC coefficient is less than .10, the assumption of independent observation can be considered met, and individual scores can be used for analysis. In this study, all ICCs were less than .10 except for the school-level ICC for knowledge, which suggest that only individual students’ knowledge data can be considered to be nested under schools. Although using a multi-level analysis model might address potential bias from the knowledge variable (Maas & Hox, 2005), the trade-off would be losing effects from individual students on the tested a priori model. We eventually chose not using a multi-level model in this analysis to preserve interpretable results because motivation is an individual-level mental process and was the focus of this study. The reader should be cautious with making their own interpretation of the results and advised to consult findings from other studies to make their final determination on “PE effects.”

To answer the research questions, the a priori model (Figure 1) was analyzed by testing the paths between the four variables. The structural equation modeling (SEM) was used to test the a priori model and its competing model. Because all variables were represented using a composite score, no latent factors to be estimated in the a priori model. Thus, a SEM-based path modeling analysis was used to answer the research questions.

Before testing the model and its alternatives, the univariate normality and multivariate normality were checked. The a priori model was a full, saturated model in which all direct effects were assumed and tested. One competing model of the full model was generated and tested in which the direct effects of knowledge and autonomous motivation for PE on out-of-school PA were not assumed. This competing model was generated based on the following rationale: (a) the model would fit the theoretical propositions of the two-pathway model of the “PE effect”; (b) the model was a more parsimonious model based on the suggestions of the modification indices. To test the model fit, the following indices were used: Chi-square (\( p > .05 \)), RMSEA (<.08), SRMR (<.08), and CFI (> .90) (Kline, 2011). The SEM was conducted using LISREL 9.30. Hayes’ PROCESS macro v3.3 for IBM SPSS (Hayes, 2013) was used to test the indirect effects involved in the model. PROCESS used the bootstrap method for inferential test of the indirect effects; the number of bootstrap samples in the current study was 5000, as recommended by Hayes (2013).

Results
Table 1 shows the descriptive results of all the variables of this study. On average, participants answered 41% of the knowledge items correct. On average, the students spent more than 1 hour per day (71.54 ± 63.39 min) on PA outside of the school. During this time, 25.32 min were spent on sport, 22.22 on fitness, and 24.00 on other PA such as walk the dog, shopping, or housework. Table 2 shows the binary correlations of all variables. Knowledge about PA and fitness was weakly correlated to autonomous motivation for PA (\( r = .19, p < .05 \)) and had no significant relationship with autonomous motivation for PE (\( r = .004, p > .05 \)) and out-of-school PA (\( r = .01, p > .05 \)). Out-of-school PA was weakly correlated to autonomous motivation for PE (\( r = .13, p < .05 \)) and PA (\( r = .14, p < .05 \)). Autonomous motivation for PE was moderately correlated with autonomous motivation for PA (\( r = .42, p < .05 \)).

Before conducting path modeling analysis, we first checked univariate normality based on skewness and kurtosis indexes. The results indicated that the

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Skew</th>
<th>Kurt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>.41</td>
<td>.17</td>
<td>.46</td>
<td>-.30</td>
</tr>
<tr>
<td>RAI-PE</td>
<td>2.47</td>
<td>5.27</td>
<td>.47</td>
<td>-.10</td>
</tr>
<tr>
<td>RAI-PA</td>
<td>4.07</td>
<td>3.24</td>
<td>.02</td>
<td>-.43</td>
</tr>
<tr>
<td>OS-PA (minutes/day)</td>
<td>71.54</td>
<td>63.39</td>
<td>1.18</td>
<td>1.58</td>
</tr>
<tr>
<td>Sport</td>
<td>25.32</td>
<td>44.60</td>
<td>2.53</td>
<td>8.66</td>
</tr>
<tr>
<td>Fitness</td>
<td>22.22</td>
<td>33.79</td>
<td>2.88</td>
<td>13.28</td>
</tr>
<tr>
<td>Other PA</td>
<td>24.00</td>
<td>35.94</td>
<td>1.97</td>
<td>4.09</td>
</tr>
</tbody>
</table>

SD = standard deviation; Skew = skewness; Kurt = kurtosis; PE = physical education; OS-PA = out-of-school physical activity.
univariate normality assumption was met based on the criterion of skewness ranging between −3 and 3 and kurtosis between −7 and 7 (Kline, 2011). We then checked the multivariate normality based on Mahalanobis distance. Mahalanobis distance was tested using the Chi-square test with a critical value of .001 to determine the multivariate outliers (Kline, 2011). Two cases were identified as multivariate outliers ($p < .001$). We then conducted a verification with the original responses from these two students’ scores and determined that these two outliers were not the result of incorrect data entry. The two outliers were then kept for analysis.

Figure 2a and Table 3 shows the results of the a priori model. The results showed that knowledge about PA and fitness had significant direct effects on autonomous motivation toward PA ($\beta = .19$, $p < .05$); so did autonomous motivation for PE on autonomous motivation toward PA ($\beta = .41$, $p < .05$). Both independent variables explained 21% variance of autonomous motivation for PA. Knowledge about PA and fitness and Autonomous motivation for PE did not have significant direct effects on out-of-school PA ($\beta = -.01$ and .09, $p > .05$; respectively). Autonomous motivation for PA had a significant direct effect on out-of-school PA ($\beta = .11$, $p < .05$). All three variables explained 3% variance of out-of-school PA. We then removed the outliers in a diagnostic attempt as suggested by Kline (2011), and found the similar results.

The a priori model is statistically saturated, which may lead to erroneous model-data fit results. We then constructed a parsimonious model, shown in Figure 2b, based on the results of the a priori model. In this model, the direct path coefficients from knowledge about PA and fitness and autonomous motivation for PE to out-of-school PA were fixed as 0. The test results from this parsimonious model showed that it fitted the data very well with the following fit indices: $\chi^2 = 2.80$, $df = 2$, $p = .25$; RMSEA = .03; CFI = .99; SRMR = .03. The standardized path coefficients are shown in Table 4. These results indicate that knowledge about PA and fitness and autonomous motivation for PE had significant direct effects on autonomous motivation toward PA ($\beta = .19$ and .41, respectively, $p < .05$); Autonomous motivation toward PA had a significant direct effect ($\beta = .14$, $p < .05$) on out-of-school PA. The SEM analysis without the outliers showed similar results. The Hayes’ PROCESS mediation model analysis was conducted to determine the indirect effects of knowledge and autonomous motivation for PE on out-of-school PA. The results showed that knowledge about PA and fitness had small, but significant indirect effect on out-of-school PA through influencing

**Table 2. Correlation matrix of all variables.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Knowledge</th>
<th>OS-PA</th>
<th>RAI-PE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OS-PA</td>
<td>.01</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>RAI-PE</td>
<td>.00</td>
<td>.13**</td>
<td>.42**</td>
</tr>
</tbody>
</table>

PA = physical activity; PE = physical education; OS-PA = out-of-school physical activity; **, $p < .01$

![Figure 2. Results from path analysis. Solid lines signify direct effect paths; broken lines indirect effect paths. PE: Physical education; PA: Physical activity; path coefficients are standardized coefficients; * $p < .05$; ** $p < .01$. (a) The SEM results of the a priori model. PE: Physical education; PA: Physical activity; ** $p < .01$, * $p < .05$. (b) The SEM results of the parsimonious model.](image-url)
autonomous motivation for PA (indirect effect = .02, SE = .01, 95% Confidence Interval = [.0007, .0424], p < .05), so did autonomous motivation for PE (indirect effect = .04, SE = .02, 95% Confidence Interval = [.0020, .0896], p < .05).

Discussion

The purpose of this study was to identify and verify the two pathways simultaneously to determine the tenability of a two-pathway model of the “PE effect”. These results indicate that the two-pathway model of the “PE effect” is tenable in terms of knowledge about PA and fitness and autonomous motivation for PE. Specifically, we found that the students’ knowledge about PA and fitness had a direct effect on their autonomous motivation toward PA and a small but significant indirect effect on out-of-school PA through influencing autonomous motivation toward PA. Their autonomous motivation for PE had a direct effect on their autonomous motivation toward PA and a small but significant indirect effect on out-of-school PA through autonomous motivation toward PA. Another noticeable result is that knowledge about PA and fitness was not significantly related to autonomous motivation for PE. One plausible reason could be that students in this study were studying the multi-activity PE curriculum in which knowledge learning was not emphasized. Students’ knowledge about PA, therefore, may not influence or be influenced by their motivation in PE.

Knowledge and out-of-school PA

The relationship between knowledge and PA behavior has been debated for some time due to inconsistent research findings. Some scholars (e.g., Ajzen, Joyce, Sheikh, & Cote, 2011) suggest that knowledge does not influence behavior, while others argue that relevant knowledge has the potential to impact behavior change because behavior change is rooted in and derived from people’s cognition (Ennis, 2007; von Glasersfeld, 1995). Our findings indicate that knowledge about fitness and actual PA behavior have a weak positive relationship. The finding can be significant in that the type of knowledge should be a central focus in designing and developing future physical education curricula to promote self-initiated motivation and behavior for lifelong physical activity (Ennis, 2015).

Most previous studies examining the relationship between knowledge about PA and fitness and PA assumed that knowledge would have a direct effect on behavior (e.g., Erwin & Castelli, 2008; Haslem, Wilkinson, Prusak, Christensen, & Pennington, 2016). Two types of research designs were mainly used in these studies. The first was a group comparison design—comparing the PA level between students who have high knowledge level and students who have low knowledge level. Several studies showed positive results using this research design. For example, Thompson and Hannon (2012) found that students who demonstrated high level of health-related fitness knowledge reported higher PA level than students who had low level of knowledge. Chen et al. (2017) also found that students in a high knowledge group had higher level out-of-school PA than students in a low knowledge group.

Table 3. Model summary of the priori model.

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>RAI-PA</th>
<th>OS-PA</th>
</tr>
</thead>
<tbody>
<tr>
<td>β</td>
<td>t</td>
<td>p</td>
</tr>
<tr>
<td>Knowledge</td>
<td>.18</td>
<td>4.09</td>
</tr>
<tr>
<td>RAI-PE</td>
<td>.41</td>
<td>9.21</td>
</tr>
<tr>
<td>RAI-PA</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>R²</td>
<td>.21</td>
<td></td>
</tr>
</tbody>
</table>
| F(2, 391)            | 51.24  | p < .01 | F(3, 390) | 3.56  | p < .01 | PA = physical activity; PE = physical education; OS-PA = out-of-school physical activity.

Table 4. Model summary of the parsimonious model.

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>RAI-PA</th>
<th>OS-PA</th>
</tr>
</thead>
<tbody>
<tr>
<td>β</td>
<td>t</td>
<td>p</td>
</tr>
<tr>
<td>Knowledge</td>
<td>.18</td>
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<tr>
<td>RAI-PE</td>
<td>.41</td>
<td>9.21</td>
</tr>
<tr>
<td>RAI-PA</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>R²</td>
<td>.21</td>
<td></td>
</tr>
</tbody>
</table>
| F(2, 391)            | 51.24  | p < .01 | F(1, 392) | 7.92  | p < .05 | PA = physical activity; PE = physical education; OS-PA = out-of-school physical activity.
The second type of research design was the correlational design—using knowledge about PA and fitness to directly predict PA behavior. Most studies adopting this type of design did not find significant results (e.g., Chen et al., 2017; Haslem et al., 2016). The debate about the relationship between knowledge about PA and fitness and PA behavior mainly results from the different findings of these two types of research studies.

Our findings suggest that the seemingly different findings of previous studies may not be contradictory to each other. That knowledge about PA and fitness did not show a direct effect on out-of-school PA (see Figure 2a) is consistent with the findings of previous studies using the correlational designs. But we did find a small but significant indirect effect of knowledge about PA and fitness on out-of-school PA through influencing autonomous motivation toward PA. This could be a plausible explanation for the findings from group comparison studies. Generally, these findings indicate that knowledge about PA and fitness does not directly influence out-of-school PA. Instead, it indirectly influences out-of-school PA. PA motivation could be one significant mediator of the indirect effect. The mechanism of positive relationship between knowledge and autonomous motivation toward PA could be that students’ knowledge about PA (e.g., concepts about PA and health-related fitness, benefits of PA, principles about developing PA plan, and strategies about self-management) increases their perceived competence and autonomy for PA, which enhances their autonomous motivation toward PA behavior. Future studies are needed to confirm this mechanism.

Our findings, to some extent, confirm the assumption of the situational-to-self-initiated motivation model that knowledge learning in PE can help students develop self-initiated motivation toward PA that leads to behavior change (Chen & Hancock, 2006). Ennis (2015) suggested that knowledge can increase the meaningfulness of the behavior through empowering people to know what and why to do and when and how to perform. Learning knowledge about PA and fitness can help develop and sustain students’ rational and voluntary participation in physical activities. Learning knowledge in PE could be one way for the “PE effect” to emerge. But it is important to for readers to note that the effects of knowledge on out-of-school PA was small. Future studies should integrate another important learning component in PE—motor skill—to see how motor skill influences motivation toward PA and subsequently influences out-of-school PA. But it did show a small but significant indirect effect on out-of-school PA through positively influencing autonomous motivation toward PA. These findings are consistent with previous findings (e.g., Hagger & Chatzisarantis, 2016). The indirect effect of autonomous motivation for PE on out-of-school PA has also been found in many other studies guided by either the trans-contextual model or the self-determination theory (e.g., Timo, Sami, Anthony, & Jarmo, 2016).

Autonomous motivation for PE and out-of-school PA

It appears that autonomous motivation for PE did not have a direct effect on out-of-school PA (see Figure 2a). Autonomous motivation is driven by the satisfaction of the needs for competence, autonomy, and relatedness and is manifested in three forms—identified regulation, integrated regulation, and intrinsic motivation (Deci & Ryan, 2000). Studies have shown that a high level of autonomous motivation can lead to adaptive outcomes such as high levels of enjoyment, engagement, achievement, performance, and wellbeing (e.g., Black & Deci, 2000). Deci and Ryan (2000) suggest that the adaptive outcomes experienced when engaging in autonomously motivated activity tends to increase one’s desire to further experience the outcomes by engaging in similar activities irrespective of the context. The mechanisms underpinning this process are psychological need satisfaction and internalization. Our findings seem to strengthen the notion, when a student experiences an activity that satisfies their psychological needs in an educational context, he/she is likely to internalize the activity into his/her repertoire of activities that satisfy his/her needs. It can be further speculated that the student would tend to actively pursue similar activities in other contexts such as in home or the community as articulated by Chen and Hancock (2006).

One noticeable aspect of the finding is that the indirect effect may be small. In our study, the indirect effect was .04 and in Hagger and Chatzisarantis’ meta-analysis study, the average indirect effect was .06. It indicates that although increasing students’ autonomous motivation in PE may contributes to their out-of-school PA, the contribution may be very limited.

It is important to acknowledge that in our study the pathway of autonomous motivation for PE in the two-pathway model was derived from the trans-contextual model. Because the goal of this study was to summarize the theoretical propositions that relate to the “PE effect” and advance a general conceptual framework to further understand the “PE effect”, other mediators (e.g., attitude, perceived control, and subjective norm) proposed in the trans-contextual model were not included in this study.

Learning knowledge in an autonomy-supportive PE environment

Chen, Martin, Sun, and Ennis (2007) suggest that two approaches are commonly used in PE curriculum to...
change students’ PA behavior. The first is the behaviorist approach which focuses on promoting in-class PA levels for students to receive immediate health benefits in PE. Studies have shown that this approach may be ineffective in term of influencing out-of-school PA and may have a negative impact on children’s motivation for future PA participation (Xiang, Chen, & Bruene, 2005). The other approach is the cognition-based approach which focuses on teaching the fact, concepts, and principles about PA and fitness. Although limited, research studies have shown that this type of PE curriculum is effective to influence the long-term PA participation among high school (Dale & Corbin, 2000) and college students (Slava, Laurie, & Corbin, 1984). These findings further indicate the contributive role of learning knowledge in PE for “PE effect” to emerge.

The findings from this study indicate that learning knowledge and increasing autonomous motivation in PE could be two ways to influence students’ PA behavior outside of the school. It implies that learning knowledge in an autonomy-supportive environment may be an effective way to promote students’ out-of-school PA. Ennis (2017) suggested that as we move into the twenty-first century, effective teaching in PE should transform from focusing on students and teachers’ in-class behavior to students’ PA behavior outside of the school. She further proposed that transformative PE curricula are needed to change students’ lives and lead to physically active lifestyles. Our findings imply that knowledge and autonomous-support learning environment should be the basis for the development of transformative PE.

Conclusion

In this study, a two-pathway model of the “PE effect” was proposed and tested. The results showed that the two-pathway model of the “PE effect” was tenable in terms of knowledge learning and autonomous motivation in PE. Specifically, it showed that students’ knowledge had a direct effect on their autonomous motivation toward PA and a small but significant indirect effect on out-of-school PA through influencing autonomous motivation toward PA. Students’ autonomous motivation for PE had a direct effect on their autonomous motivation toward PA and a small but significant indirect effect on out-of-school PA through autonomous motivation toward PA. These findings imply that teaching knowledge in an autonomy-supportive PE environment may be an effective way to promote students’ out-of-school PA behavior.

What does this article add?

This article has provided an integrated conceptual framework, the two-pathway model of “PE effect”, to further our understanding about how PE can influence students’ PA behavior outside of the school. Findings reported in this article suggest that knowledge and autonomous motivation can be two foundations for the development of transformative PE. In addition to the contribution to the “PE effect” research, this article also contributed to the research about the relationship between knowledge and behavior change by providing new explanations about the contradictory findings from previous studies.

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References


