Physical activity and fitness knowledge learning in physical education: Seeking a common ground

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Abstract:

Motivation to learn is a disposition developed through exposure to learning opportunities. Guided by the expectancy-value theory of Eccles and Wigfield (1995), this study examined the extent to which expectancy belief and task value influenced elementary school students' physical activity and knowledge learning in physical education (PE). Students ($N = 753$) from 15 US public schools contributed student-level and class-level data. With a 2-level design, the data were analyzed using hierarchical linear modeling. Physical activity ($t = 3.18$; $p < .01$) positively predicted fitness knowledge. Attainment value (i.e. perception of importance) as the only expectancy-value construct, significantly predicted fitness knowledge ($t = 3.07$; $p < .01$), when physical activity was held constant. As the physical activity intensity increased, the positive prediction of attainment value to knowledge attenuated and then turned negative ($t = –3.10$; $p < .01$). The study indicated that although a physically-active context helps students to make sense of fitness knowledge, a vigorous context shifts their motivation away from cognitive learning, toward physical participation. To resolve the difficulty of attaining learning objectives both physically and cognitively, PE teachers may want to maintain an active learning context with moderate physical intensity. Future research should address the effect of learner motivation on dual or multiple learning outcomes in PE.

Keywords: Knowledge | learning | physical activity | physical education | motivation | expectancy beliefs | task values

Article:

Introduction

An important goal of physical education (PE) is to educate students with the necessary "knowledge to make decisions and solve problems associated with performance and well being" (Ennis, 2007: page 139). Health-related fitness knowledge, fitness knowledge in short, refers to the concepts and principles about our body's ability to move effectively and efficiently for disease prevention and health promotion (Corbin et al., 2011). Fitness knowledge is often taught in Kindergarten through 12th grade (K-12) PE in the US (Corbin et al., 2011), where it is deemed as essential learning content (Cale et al., 2007). In practice, students' achievements in constructing fitness knowledge might be impacted by dispositional motivation (Chen and Ennis, 2009) and the educational context that is enriched by physical activity (Xiang et al., 2006). Understanding students' motivation and its impact on learning under various contexts is important and warrants empirical research.

Recent research recognizes expectancy beliefs and perceived task values as strong motivators among K-12 students in PE (Chen et al., 2012). There seems to be a need to determine the function of expectancy belief and task values in impacting student learning. In addition, while both physical and cognitive learning are targeted during instruction, whether students' physical activity participation would influence students' cognitive learning (e.g. fitness knowledge) remains elusive. In an intuitive sense, PE classes are characterized by physical activity that is organized by teachers, which might constrain students' cognitive learning, especially when physical activity becomes a major focus of the instruction. This presumption appears to be untrue. Recent research identifies the feasibility of enhancing students' conceptual understanding while maintaining moderate physical activity in a constructivist-themed PE curriculum (Chen et al., 2007). Further empirical research is needed to articulate the relationships among expectancy-value constructs, physical activity and fitness knowledge learning in PE.

The expectancy-value theory

Definition of motivation. Learner motivation is pivotal for engagement and learning in PE (Chen and Ennis, 2009; Rink, 2001). Motivation refers to the process whereby goal-oriented human behaviors are instigated and sustained (Pintrich and Schunk, 2002). In this regard, motivation consists of two components: level of energy and the direction to which the energy is channeled. In schooling, it is important to direct students' motivation energy toward meaningful educational outcomes, so that students can not only enhance their achievement/performance but also appreciate the value of learning experiences (Alexander, 2006; Brophy, 2004).

The expectancy-value constructs. *Expectancy beliefs* and *task values* are two primary sources from which K-12 students acquire motivation in schooling (Eccles and Wigfield, 1995; Xiang et al., 2003). Expectancy beliefs refer to a learner's judgment on how well he or she will perform in an upcoming learning task (Eccles and Wigfield, 1995). Task values are perceived as the worth that a task may provide for current and future life (Eccles and Wigfield, 1995). The perceived values that are observed across academic areas and PE include: attainment value, intrinsic value, utility value and cost (Eccles and Wigfield, 1995; Xiang et al., 2003). These values allude to a learners' perception or judgment on the importance (i.e. attainment value), enjoyment (i.e. intrinsic value), and usefulness (i.e. utility value) of a given task. The stronger expectancy beliefs and perceptions of task values indicate a higher level of motivation. Additionally, cost is defined as the expense or negative consequence of engaging in a task (Eccles and Wigfield, 1995). A learner may perceive fatigue, physical discomfort and incompetent ability as costs in PE (Xiang et al., 2006).

Motivational effect of expectancy beliefs and task values

The expectancy-value constructs have distinct motivational influences on outcome variables across educational domains. Expectancy beliefs and task values are predictive (Durik et al., 2006) of high school students' choice for leisure-time reading (i.e. hours per week reading), career aspirations (i.e. pursuing occupations in which literacy skills are important) and course registration (i.e. the number of language arts classes taken). Specifically, expectancy beliefs predict all three outcome variables, attainment value predicts course registration and career aspiration, and intrinsic value predicts leisure reading and course registration. Students tend to make wiser choices when they anticipate success and value the content in literacy education. In college mathematics and psychology courses, students' perceived utility value of the course content positively predicted their interest and performance in problem-solving, among participants with lower prior or expected performance (Hulleman et al., 2010). This research shows that the motivational effect of expectancy-value constructs differs across subjects' ages or their schooling levels.

Subject to the outcome variables and age or grade of the population, expectancy beliefs and task values also function differently in PE. Previous research demonstrated that expectancy beliefs predict fourth grade students' 1-mile run performance, and that intrinsic value and attainment value predict intention of future participation in running (Xiang et al., 2004). At the middle-school level, expectancy beliefs predict cardiorespiratory fitness performance; while expectancy beliefs, attainment value and intrinsic value predict engagement and satisfaction (Gao, 2009).

Noticeably, expectancy beliefs and task values possess significant, but varied, motivational functions. In elementary PE, there seems to be a gap of evidence on whether expectancy-value motivation would promote students' fitness knowledge, as important learning content. Constructing fitness knowledge can be motivational in nature. It informs students of the importance and usefulness of developing and sustaining physical fitness. For example, the FITT principle guides students to develop appropriate exercise plans by making decisions on the frequency, intensity, type and time of exercise. The knowledge, when mastered, can potentially facilitate students to exercise safely and scientifically. As such, fitness knowledge may possess essential values to be espoused by learners.

Intuitively, expectancy-value constructs may stand out as motivational drivers to promote fitness knowledge. Nevertheless, empirical evidence that addresses the association between expectancy-value constructs and fitness knowledge is not available and hence, is needed.

Physical activity and fitness knowledge

Motivation and learning should be articulated by taking into account the characteristics of the learning contexts (MacPhail et al., 2008; Moje et al., 2004). One salient contextual characteristic in PE classes is physical activity (Wuest and Bucher, 2006). Physical activity, as a common vehicle for engagement and learning, features the domain specificity of PE (Shen et al., 2008).

This characteristic dictates, to some extent, the motivational functions of the expectancy-value constructs.

On the one hand, the socio-cultural constructivism theory stipulates that the context in which students reside bears strong influence on their learning behaviors and outcomes (Moje et al., 2004). As students learn and socialize in school, they construct understanding by synthesizing the multiple sources of knowledge originated from daily experiences in formal institutions (e.g. school) and informal environments (e.g. peer networks) (Moje et al., 2004). In PE, the physical activity participation and the fitness knowledge learned from instruction constitute two important sources of knowledge for learning that are relevant to each other, as fitness knowledge offers the scientific explanations for physical fitness and exercising. Offering a context that is enriched by physical activity may provide an engaging environment for students to construct fitness knowledge with enhanced efficiency. Empirical evidence supports the above theoretical framework that structured physical activity has the potential to serve as a medium to enhance students' health-related exercise knowledge (Fairclough et al., 2008).

On the other hand, physical participation may bear a negative influence on cognitive learning. As reported previously (Xiang et al., 2006), when physical activity becomes vigorous, students experience physical discomfort (e.g. fatigue) and perceive it as a barrier. Such barriers were found to undermine students' motivation in PE (Chen and Liu, 2009). Thus it was assumed that physical activity could play a controversial role in student cognitive learning and engagement. Along this school of thought, the second research purpose of this study is to identify the extent to which physical activity influences cognitive learning.

This study addresses two research questions:

1. To what extent does students' expectancy-value motivation predict fitness knowledge in elementary school PE?
2. To what extent does physical activity influence fitness knowledge?

Informed by existing literature, it is hypothesized that expectancy-value constructs would positively predict fitness knowledge and that moderate intensity of physical activity would facilitate fitness knowledge.

Methods

This section elaborates the quantitative methods used to address our two research questions. The methods are described and organized in the following sequence: research design of the study, sampling approach, research setting, participants, variables and measures, data collection, data reduction, and data analysis.

Research design

A correlational design was adopted to fulfill the research purposes of this study. The design belongs to the family of non-experimental designs that serve for descriptive/predictive or explanatory/interpretative purposes (Pedhazur and Schmelkin, 1991). This study followed closely the scope of the explanatory/interpretative design, in which well-developed theoretical articulations of complex relationships among variables are desired. The research design served well for the present study that sought explanatory relationships among expectancy-value motivation, fitness knowledge and physical activity on the basis of the existing research literature.

Sampling, setting and participants

This study was part of a 3-year research endeavor on a fitness education curriculum, in a large school district of the US. The curriculum emphasized constructing health-related fitness knowledge, acquiring skills of lifetime physical activities, and nurturing personal and social responsibility for healthful living. The school district shared similar characteristics with the 100 largest US school districts on five key education characteristics: socio-economic status, ethnicity, student enrollment, teacher-student ratio and financial expenditure per person (National Center for Education Statistics, 2008). Based on the above characteristics, the elementary schools ($N =$ 133) within this school district were classified into 15 sampling brackets. One school in each bracket was randomly selected and then one class in each grade within the selected school was randomly chosen as the data-providing class. To address the research questions, the present study utilized the data from the 15 schools in the experimental group, during the third year. The study was approved by the Institutional Review Board. Participation in the study was voluntary. Written parental/guardian consents and student assents were secured prior to data collection. We informed the participants of their right to decline or withdraw from the study, any time in the process.

Variables and measures

Expectancy-value constructs. The adapted *Expectancy-Value Questionnaire* (EVQ) (Xiang et al., 2003; Zhu et al., 2012) was used to measure students' expectancy-value motivation. The self-reporting questionnaire was previously validated in elementary school PE (Xiang et al., 2003). The wording of the original items was slightly modified (from general PE to concept-based PE) to better reflect the focus of the curriculum that we implemented. Expectancy beliefs were measured by five items on a 5-point Likert scale. An example is, "How well do you think you are doing in learning concepts in PE?" (1 = *very poorly* to 5 = *very well*). Each of the four perceived task values was measured using two items that also were scored on a 5-point Likert scale. For example, an item measuring the attainment value was: "Compare [sic] to math, reading, and science, how important is it for you to learn science in PE?" (1 = *not very important*, 5 = *very important*); an item for the utility value was: "Some things that you learn in school help you do things better outside of school. This is being called useful [sic]. For example, learning about plants at school might help you grow a garden at home. Can you tell me how useful you think the concepts learned in PE classes are?" (1 = *not useful at all* to 5 = *very useful*); an item for the intrinsic value was: "How much do you like your PE classes?" (1 = *don't like it at all* to 5 = *like it very much*) and a questionnaire item for cost was: "If there is anything that you don't like in PE, what would that be? Why?"

Fitness knowledge. A standardized knowledge test was used to measure students' fitness knowledge. The test was validated using the known-group method (Chen et al., 2006). All questions for different grade levels had a difficulty index value of 50% (5% range of variation) and a discrimination index value greater than 40%. The questions in the test were developed for each grade level. The number of questions in each test ranged from 10 to 13, in a multiple-choice format. Each question had only one correct answer and the percentage-correct score was used as the knowledge score.

Physical activity. We employed RT3 accelerometers to measure physical activity (Monrovia, CA). The accelerometer was utilized in many prior studies that demonstrate sound validity and reliability in measuring physical activity and/or energy expenditure (Hale et al., 2007; Hussey et al., 2009; Vanhelst et al., 2010). Accelerometers recorded two forms of data: vector magnitude (VM) and energy expenditure. VM refers to the movement counts that are measured and recorded in three physical planes (i.e. mediolateral, anteroposterior and vertical). Energy expenditure was measured based on VM data, after taking into account participants' age, gender, body weight and height. The energy expenditure recorded by RT3 accelerometers is equal to the total energy expended by participants during the time of measurement. The RT3 accelerometer is a precise instrument to measure students' physical activity and energy expenditure during PE lessons. Due to its high portability, students can participate in the organized physical activities without restrictions.

Data collection

The above self-reporting and behavioral data were collected by trained data collectors. We recruited kinesiology undergraduate and graduate students to be data collectors; they were trained to follow a standardized data collection protocol. In training, each data collector practiced the protocols independently for multiple times, after learning the procedures. Their questions about the procedures were addressed immediately by the researchers. Each data collector demonstrated sufficient competence for independent data collection by meeting the criteria listed on an evaluation check-list. The above data collection training session lasted for approximately 3 hours.

The EVQ and the standardized knowledge test were administered in sequence, in the gymnasium. The participants were informed about the purpose of the measurements and were instructed to respond independently to the question items. They were reassured that their responses would be kept confidential and would pose no impact on their grades nor school standing. Data collectors read aloud and clearly the instructions, question items and answer choices. The participants were encouraged to ask questions anytime during the process and these were addressed immediately. Their participation was appreciated at the end of each data collection session. The PE teachers remained in the setting during data collection, to help manage students.

Two non-consecutive instructional lessons were arranged for each class, to collect physical activity data. Three boys and three girls of diverse ethnic background, ability and body mass index (BMI) were selected as class representatives. Data about the students' height, weight, gender and age were collected prior to the lessons, to individually configure the accelerometers. Participants were instructed to put the pre-configured RT3 accelerometers on their waistband, directly above the right knee, during class time.

Data reduction

The self-reported responses to the items on the EVQ were entered and reduced by the constructs (i.e. expectancy beliefs, attainment value, intrinsic value and utility value). We sorted out the completed questionnaires in alphabetical order, by last name. We then entered the responses into the data computer, item by item, for all the participants. Next, we computed the aggregated scores for the four expectancy-value constructs. No numerical processing was operated for the two open-ended items for cost, due to their remote relevancy to this study's research questions.

Knowledge scores were assessed and then entered in the same SPSS data set, as motivation variables. During the assessment, we referred to an answer key established previously in accordance with the recent scientific knowledge base. We scored responses dichotomously, with correct answers scoring "1" and wrong answers scoring "0." We then computed the percentage of correct scores and entered these values in the data set, for each participant, to indicate their understanding of fitness knowledge.

While motivation and knowledge variables were summarized by individual students, two types of physical activity data were reduced and entered by class: VM/minute and the metabolic equivalent (MET). The first refers to the average raw physical activity count in three physical planes, per minute, and MET refers to the units of energy expenditure. One MET represents the amount of energy expended during resting; while larger MET scores indicate higher-energy expenditure relative to resting (Fulton et al., 2001). The thresholds of physical activity intensity are categorized as light (1.1–2.9 METs), moderate (3.0–5.9 METs) and vigorous (above 6.0 METs), as per the US Department of Health and Human Services (2008). Physical activity, as a contextual variable, was therefore determined by the mean VM/min and MET of the six student representatives from each class.

Data analysis

As shown above, we measured students' expectancy-value constructs and knowledge at the student level, and their physical activity at the class level. We employed hierarchical linear modeling (HLM) to analyze the nested data (Raudenbush and Byrk, 2002).

To address the research questions of the study, knowledge score was specified on HLM as the outcome variable predicted by expectancy beliefs, attainment, utility and intrinsic values at the student level, but physical activity variables at the class level. Hence, the following models were established using HLM 6.0 (Raudenbush and Bryk, 2002). At the student level, the linear model was:

$$\text{Knowledge} = \beta_{0i} + \beta_{1i}(\text{EB}) + \beta_{2i}(\text{AV}) + \beta_{3i}(\text{IV}) + \beta_{4i}(\text{UV}) \qquad 1$$

In Equation 1, the knowledge score is the outcome variable; β_{0i} is the intercept; β_{1i}, β_{2i}, β_{3i} and β_{4i} are the slopes of expectancy beliefs (EB), attainment (AV), intrinsic (IV) and utility values (UV); e_{ij} is the error term that is unexplained by the student-level model.

At the class level, the models were:

$$\beta_{0i} = \gamma_{00} + \gamma_{01} \text{ (PA)} + u_{0i} \qquad 2$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11} \text{ (PA)} + u_{1i} \qquad 3$$

$$\beta_{2i} = \gamma_{20} + \gamma_{21} \text{ (PA)} + u_{2i} \qquad 4$$

$$\beta_{3i} = \gamma_{30} + \gamma_{31} \text{ (PA)} + u_{3i} \qquad 5$$

$$\beta_{4i} = \gamma_{40} + \gamma_{41} \text{ (PA)} + u_{4i} \qquad 6$$

In Equation 2 through Equation 6, the symbols γ_{00}, γ_{10}, γ_{20}, γ_{30} and γ_{40} are the intercepts of the class-level models; γ_{01}, γ_{11}, γ_{21}, γ_{31} and γ_{41} are the slopes of physical activity; u_{0i}, u_{1i}, u_{2i}, u_{3i} and u_{4i} are the error terms in the class-level models. VM/min or MET were entered separately into the models, as both represent similar physical activity.

The HLM 6.0 would generate two primary sets of results: (a) statistical results for the hierarchical model; and (b) significance test results for residual components, at two levels. These two steps yield a series of statistics. Specifically, the hierarchical model testing generates an unstandardized model coefficient, standard error, t statistic and significance value; while the significance testing for residual components generates the variance component, degree of freedom, χ^2 statistic and significance value.

We operated a procedure of listwise deletion to deal with missing data (Allison, 2001). The confidence interval (CI) for analysis was determined at 95% (i.e. $\alpha = .05$). The unstandardized scores (scores on their original scales) were reported and interpreted, to make sense of the data. Statistical assumptions of normality, homogeneity and independence were tested for possible violations.

Results

Based on the above data analyses, research results emerged: The following paragraphs are arrayed by description of the sample, construct validity of the EVQ, descriptive analysis results and the HLM results. These results are literally interpreted in regards to the research questions.

Description of the sample

A total of 753 students in the third (n = 243), fourth (n = 243), and fifth grades (n = 257) from 15 elementary schools contributed self-reporting and behavioral data. This sample represented students from diverse ethnic backgrounds (Asian: n = 133 or 18%; African American = 114, 15%; Caucasian = 261, 35%; Hispanic = 106, 14%; missing = 39, 5% and other = 100, 13%) and both genders (male = 353, 47%; female =371, 49%; missing = 29, 4%). In addition, because the listwise deletion procedure (Allison, 2001) was defaulted to handle missing data on HLM6.0, less than one-third of the data cases were automatically deleted by the software to retain a sample of participants who contributed intact data to every variable. The final sample for HLM analysis consisted of 491 third, fourth and fifth grade students from 27 classes.

Construct validity of the EVQ

The Cronbach alpha coefficients for the expectancy-value constructs ranged from .65 to .89 (α: expectancy beliefs = .81, attainment = .65, intrinsic = .89 and utility = .76). The confirmatory factor analysis model showed satisfactory fit indices (x^2_{39} =105.17, $p < .05$; Comparative Fit Index = .967; Root Mean Square Error of Approximation = .046, 90% CI = .035, .056; Standardized Root Mean Square Residual = .039). These results suggest that the integrity of the expectancy-value constructs was preserved.

Descriptive analysis results

Table 1 shows the descriptive results about sample size, mean and standard deviation for expectancy-value constructs, physical activity and fitness knowledge. The participants in all three grades reported relatively high scores on expectancy-value constructs, using a 5-point Likert scale (ranging from 4.06 ± .91 to 4.25 ± .93). It indicated that the students, on average, demonstrated relatively high motivation in this PE curriculum. They not only possessed a high expectation to become successful, but also valued the learning content in the programme. The participants' performance on the standardized knowledge test was 60.2% ± 21.5%, indicating a moderate conceptual understanding about fitness knowledge. The physical activity intensity of the learning environment was on average 4.84 ± 2.19 METs, a moderately active level (Moderate = 3.00–5.99 METs).

Table 1. Descriptive statistics of motivation and learning.

	N	*M*	*SD*
Expectancy-beliefs	737	4.07	.72
Attainment value	740	4.08	.85
Intrinsic value	753	4.25	.93
Utility value	752	4.06	.91
MET[a]	27	4.84	2.91
Physical activity[a]	27	1473.24	512.49
Fitness knowledge	742	60.2%	21.5%

[a]Class level variable
M: Mean; MET: metabolic equivalent; SD: standard deviation

The HLM results

Table 2 and Table 3 illustrate the results from HLM. The HLM models that specified VM/min (i.e. raw physical activity counts in three dimensions) as the class-level physical activity yielded statistically significant results, while the models that specified METs as the variable did not show any statistical significance. The numeric results from the HLM with VM/min are gathered and interpreted below.

Shown in Table 2, the HLM results demonstrated that: (a) physical activity positively predicted fitness knowledge (VM/min model: $\gamma_{01} = .000569$; $t = 3.18$; $p < .01$) and (b) attainment value positively predicted fitness knowledge when physical activity was held constant (γ_{20} =

.078357; $t = 3.07$; $p < .01$). These findings indicate that students tended to learn fitness knowledge better when they were positioned in a physically active setting and when they perceived the learning content as personally important.

Table 2. Statistical results for the hierarchical model.

Fixed effect	*b*	se	*t*	*p*
Knowledge mean				
Intercept, γ_{00}	–.280658	.265277	–1.06	.30
Physical activity, γ_{01}	.000569	.000179	3.18	< .01
Expectancy beliefs				
Intercept, γ_{10}	–.030922	.040394	–.77	.45
Physical activity, γ_{11}	.000029	.000028	1.04	.31
Attainment value				
Intercept, γ_{20}	.078357	.025507	3.07	< .01
Physical activity, γ_{21}	–.000058	.000019	–3.10	< .01
Intrinsic value				
Intercept, γ_{30}	.026885	.039841	.68	.51
Physical activity, γ_{31}	–.000017	.000028	–.61	.55
Utility value				
Intercept, γ_{40}	.064689	.062742	1.03	.31
Physical activity, γ_{41}	–.000046	.000040	–1.16	.26

[b]estimated value of un-standardized regression coefficient; se: standard error

Table 3. Significance test results for residual components at two levels.

Random effect	Variance component	*df*	x^2	*p*
Knowledge mean, u_{0i}	.04	25	26.62	.38
Expectancy beliefs, u_{1i}	< .01	25	17.63	> .50
Attainment value, u_{2i}	< .01	25	27.69	.32
Intrinsic value, u_{3i}	< .01	25	22.27	> .50
Utility value, u_{4i}	< .01	25	28.99	.26
Level-I effect, *r*	.02			

The HLM results (Table 2) further demonstrated that the predictive effect of attainment value on fitness knowledge was negatively predicted by physical activity ($\gamma_{21} = -.000058$; $t = -3.10$; $p < .01$). In a numeric sense, the prediction of attainment value to fitness knowledge shrank as physical activity intensity increased from 0 to 1350.98 VM/min, or 4.32 METs. It continued shrinking as physical activity intensity exceeded the 4.32 METs threshold. This finding implied that the students' perception of importance (i.e. attainment) in the PE curriculum had shifted away from learning fitness knowledge to something else: mostly likely, the physical activity. There were no significant differences in knowledge score, expectancy beliefs, attainment, intrinsic and utility values among the classes with the presence of physical activity ($p > .05$).

Table 3 shows the significance test results for residual components at two levels. No statistical significance was found, indicating that the students across the 27 classes did not considerably differ in fitness knowledge, expectancy beliefs, attainment value, intrinsic value and utility value. The findings imply that the students demonstrated equal levels of expectancy-value motivation and conceptual understanding of fitness knowledge.

Discussion

This study yielded several research findings based on the statistical analysis of HLM. The following paragraphs summarize and interpret these findings, discuss each finding in relation to previous theoretical articulation, and elaborate on the implications for both theory and practice. The discussion is organized by these topics: (a) motivation for enhanced fitness knowledge, (b) knowing through moving, and (c) fitness knowledge and physical activity: locating the common ground.

Motivation for enhanced fitness knowledge

This study captured the marginal direct effect of attainment value on fitness knowledge scores while physical activity was held constant. It indicated that the stronger perceptions of importance that students possess regarding fitness knowledge, the more likely they will construct the knowledge efficiently. This finding supports our earlier assumption that health-related fitness knowledge has inherent value that may be naturally inviting and motivating. Unexpectedly, no other expectancy-value constructs stood out as significant predictors of fitness knowledge in this study.

As documented in previous studies, attainment value is a strong motivator in PE and other school subjects (Durk et al., 2006; Gao, 2009; Hulleman et al., 2010; Xiang et al., 2004, 2006). In his seminal publications, Brophy (2004, 2008) highlights that schools should not only nurture students' content competency, as assessed by standardized tests, they should further scaffold students the appropriate motivation so that they become appreciative of the learning content and experiences. These findings support Brophy's assertion. Health-related fitness knowledge is a proper learning content in PE, at least at the elementary school level, that is not only perceived as important (i.e. attainment value) by the students, but also motivates them to efficiently construct the knowledge. It seems to be content that should be fully incorporated into the PE curriculum and instruction, to reap maximal learning outcomes and health benefits (Corbin et al., 2011).

The approach to delivering fitness knowledge deserves attention. As documented in the existing literature, offering health-related knowledge and organized physical activities separately was demonstrated to successfully promote students' fitness knowledge and physical activity (Corbin and Cardinal, 2008; Dale et al., 1998). Nevertheless, conceptual PE (Dale et al., 1998) was designed primarily to educate high school and college students, but it has limited applicability to younger students. The other approach to promoting students' knowledge understanding and potentially sustained physical activity is "knowing through moving," as is presented in the next section. This approach is advocated, as it is substantiated by evidence from the present study.

Knowing through moving

Physical activity promotion is a mainstream initiative, due to its association with health (Fairclough and Stratton, 2005; Green and Thurston, 2002; US Department of Health and Human Services, 2000, 2008). In PE, physical activity is not only an indispensable component; it is also the common vehicle through which students pursue other learning goals (Fairclough and Stratton, 2005; Wuest and Bucher, 2006). A second important finding of the present study is that the physically-active learning context facilitated students' fitness knowledge. Our finding is consistent with prior research that found organized physical activity has the potential to promote health-related knowledge (Fairclough et al., 2008).

Curriculum theorists argue that a coherent PE curriculum has the efficacy to empower students to make sense of their experiences in the learning process, which in turn can enhance engagement and learning outcomes (Beane, 1995; Ennis, 2008). Based on this argument, it was inferred that the students in the targeted PE curriculum in the present study were able to kinesthetically interact with and understand the fitness knowledge. That is, when the fitness knowledge was introduced in the curriculum, the students were afforded the opportunity to think and reflect upon the knowledge, as they were moving around the gymnasium. The teachers' instruction about fitness knowledge and the students' kinesthetic interactions therefore constituted two important sources of knowledge from which a sense of relevancy was perceived and appreciated (Ennis, 2008; Moje et al., 2004). The sense of relevancy between personal experiences and the learning content might have instigated adaptive learning behaviors and enhanced learning outcomes.

This finding urges researchers and teachers to stress the importance of offering a meaningful learning context, where students can connect their physical experiences to the related knowledge. Much of the learning content in PE is pertinent to students' physical experiences. Thus, it is important that physical educators take the initiative to organize activities for the sake of physical activity promotion and for the interest in enhancing students' understanding of health-related knowledge (e.g. fitness knowledge) that may facilitate voluntary physical activity participation in leisure time.

Fitness knowledge and physical activity: Locating the common ground

The present study further revealed that the association between attainment value and fitness knowledge was negatively predicted by the learning context enriched by physical activity. That is, the prediction of attainment value to fitness knowledge decreased as physical activity intensified. Our finding indicated the need to take into account physical activity as an essential contextual variable while articulating students' motivation and cognitive learning in PE.

Clearly, an active or overactive learning context will change the nature and function of students' motivation. While locating the cause for this attenuation effect of physical activity went beyond the HLM results of this study, two explanations were inferred to on the basis of previous theoretical articulations. First, learning through physical activity manifests the domain specificity of PE (Shen et al., 2008). As a school subject with multi-dimensional learning goals (National Association for Sport and Physical Education, 2004), PE is expected to nurture students physically, cognitively and socially. In accomplishing these learning goals, physical educators often find it difficult to conduct their instruction with an equal emphasis across the three domains. Consequently it would be unsurprising when students shift their motivation and energy from reaching one learning goal to another.

Hence, a plausible explanation for the attenuation effect is that with an increase in physical intensity, the students' motivation for learning fitness knowledge cognitively might have shifted toward conquering the demand of succeeding in physical activity tasks or mastering a motor skill. As such, strenuous physical activity will deter students' motivation, moving it away from cognitive tasks.

A second explanation is pertinent to students' physiological responses (e.g. feeling tired or fatigue) accompanying their vigorous or strenuous physical activities. Previous research (Xiang et al., 2006) reveals that elementary school students identify the physical discomfort experienced in PE as a barrier. As a result, the discomfort might have constrained them from recognizing the values inherent in the knowledge, both physically and cognitively. Future research should investigate the nature of these barriers and their impact on students' motivation and learning in PE.

Regardless of the causes for the attenuation effect seen, a learning context enriched in vigorous physical activity detaches learners' attainment value and possibly expectancy beliefs, intrinsic value and utility value from learning fitness knowledge. This finding acts as an alarm that the PE professionals should consider judiciously the immediate impact of vigorous physical activity on cognitive learning. Admittedly, from the public health perspective, it is widely accepted that people, including young children, should engage in moderate-to-vigorous physical activity, to receive optimal health benefits (National Association for Sport and Physical Education, 2004; US Department of Health and Human Services, 2000, 2008). Nevertheless, from an educational perspective, vigorous physical activity tends to shift around the students' engagement motivation, which therefore could change students' choice and efforts to attain success in other aspects (e.g. understanding fitness knowledge).

The above reasoning suggested that PE professionals should offer a moderate intensity of physical activity (regardless of the content) during instruction, so that students could receive the health benefits from their participation, as well as be able to remain focused on achieving cognitive learning goals. This finding has important implications when teachers endeavor to accommodate students of different ability levels and genders. Previous research found that female and low-ability students tend to engage in physical activity of lower intensity than the male and high-ability students (Fairclough and Stratton, 2005). In a practical sense, as moderate physical activity is not as demanding, it may be easily accepted by students of all abilities and genders, as well as motivation levels.

Conclusion

Taken together, physical activity serves as a double-edged sword. On the one hand, a physically active educational context facilitates students' fitness knowledge. On the other hand, an increasingly more active environment undermines students' motivation (i.e. attainment value) toward fitness knowledge. This set of findings suggested that when there is a need to pursue both physical and cognitive learning achievements in a regular PE lesson or unit, it is important to seek a common ground where students can attain and enjoy success in both. The evidence showed that moderate physical activity is ideal, in order to neutralize the trade-off effect and benefit student engagement and learning, physically and cognitively.

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