

Situational interest, cognitive engagement, and achievement in physical education

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Abstract:

Students' learning has been the center of schooling. This study examined the contribution of situational interest motivation and cognitive engagement in workbooks to student achievement in learning health-related fitness knowledge. Situational interest, performance on solving workbook problems, and knowledge gain in cardio-respiratory fitness and benefits were measured in 670 third-grade students from 13 randomly selected urban elementary schools. Structural equation modeling and regression curve estimation analyses revealed that situational interest contributed little to workbook performance and knowledge gain. Performance on solving workbook problems contributed significantly to knowledge gain. The results also show that skipping workbook tasks had stronger negative impact on knowledge gain than performing the tasks incorrectly, suggesting the importance of engaging students in the learning process by attempting the workbook tasks. The findings reinforced the value of using workbooks to facilitate cognitive knowledge learning in physical education, but raised questions about the direct function of situational interest on engaging students in cognitive learning.

Keywords: Situational interest, Learning, Physical education

Article:

1. Introduction

A challenge facing physical education is to offer students meaningful learning opportunities that are beyond a "busy, happy, and good" experience (Goodlad, 2004; Placek, 1983). As Rink (2005) suggested, educational physical education programs should be offered in schools to emphasize students' knowledge and skill learning. From a constructivist's point of view, learning is not a replication or reproduction of knowledge and skills but an active meaning-making process that the learner actively engage in (Dewey, 1916). In this sense, learning in physical education takes place when students actively construct and reconstruct knowledge and skills meaningful to their current and future lives. Thus, learning in physical education should be understood not only as learner construction of knowledge and skills but also as a process of cognitive engagement in knowledge and skills construction (Chen & Ennis, 2004). During this process, learner motivation plays a critical role. Classroom-based research has demonstrated that motivated students are better able to construct knowledge and skills to achieve learning goals (Hidi & Harackiewicz, 2000). The purpose of this study was to examine the contributive relationship between situational interest, a profound motivator for learning (Hidi, 1990), cognitive engagement, and achievement in elementary-school physical education.

2. Constructivist learning in physical education

The constructivist perspectives of learning postulate that learning relies on meaningful interactions of the learner with the content, context, experienced others, and knowledgeable and even novice peers. One essential interaction for learning to take place is the direct, meaningful interaction between the learner and the content. This type of interaction can be observed in physical education as the learner not only engages in physically doing a task but also cognitively constructs the meaning of the "doing." Experienced physical education teachers often use task cards, posters, verbal descriptions and explanations and peer-interaction strategies (e.g.,

“think, pair, share”) to assist the meaning construction. Thus, whether or not a physical education curriculum provides ample opportunities and tasks for learners to actively deliberate the meaning of physical movements to form their own knowledge structure about the movements can be an important distinction between the conventional and constructivist curriculum (von Glasersfeld, 1995). According to this perspective, merely asking learners to respond to what is presented to them may not be a desired learner–content interaction. An effective constructivist approach will involve the learners to engage in conceptual constructions of knowledge presented to them and provide opportunities for them to apply that knowledge to their life experiences.

2.1. Learning defined in physical education

Learning in physical education is multi-dimensional. Traditionally, the learning goals of physical education curricula are based on a three-pillar framework: cognitive knowledge, psychomotor ability, and affective characters. Recent curriculum innovations have placed an emphasis on learning health-enhancing physical activity and knowledge and skills associated with the activity (Cone, 2004; Corbin, 2002). It is assumed that to become physically educated (National Association for Sport and Physical Education NASPE., 2004), students should not only participate in physical activities, but also understand, cognitively, the reasons (why) and mechanisms (how) physical activities help them develop and maintain health. Learning health-related cognitive knowledge through actual physical activity participation has become more important than ever before in physical education.

In a large randomized controlled trial, Chen, Martin, Sun, and Ennis (2007) compared a constructivist physical education curriculum with traditional ones on student in-class physical activity levels measured by accelerometers. Despite that the constructivist curriculum is concept-based teaching health-related fitness knowledge; findings of the study suggest that there is no significant difference in student in-class physical activity between two different curriculum conditions. In a constructivist physical education curriculum, such as the Be Active Pals!, students are able to acquire cognitive knowledge (Chen, Ennis, Martin, & Sun, 2006), engage in moderate physical activity (Chen et al., 2007), and maintain interest-based motivation for physical education (Sun, Chen, Ennis, Shen, & Martin, 2008). Researchers have emphasized that learning is domain specific (Alexander, 2006). Learning in a domain, such as physical education, usually requires a unique knowledge construction process that is consistent with the nature of knowledge and skills to be learned. The content specificity issue has been documented in physical education where students’ physical activity levels often vary in accordance with the content (Chen et al., 2007). What is not clear is the extent to which learner engagement in cognitive learning tasks contributes to their knowledge acquisition in physical education.

2.2. Cognitive engagement in physical education

From a constructivist perspective, cognitive engagement refers to the extent to which students are attending to and expending mental effort in the learning tasks encountered (e.g., efforts to use knowledge and cognitive strategy to complete a task; Chapman, 2003). According to Pintrich and Schrauben (1992), students’ cognitive engagement represents a motivated behavior associated with their persistence on difficult tasks and the usage of cognitive strategies. In education, using written tasks that focus on personally meaningful experiences can facilitate behavioral and/or cognitive changes that lead to knowledge and skill re-construction (Mason, 2001). As Mason (2001) argued, writing engages learners because it “forces” them to think through their ideas. To enhance cognitive engagement, using student workbook to provide writing tasks have been widely used in many school subject areas such as reading (Cunningham, 1984) and mathematics (Cueto, Ramirez, & Leon, 2006). Although task cards are used occasionally in physical education, using workbook throughout the curriculum is not a very common practice. In a recent curriculum intervention study, Chen et al. (2007) found that extensive use of student workbooks in physical education lessons may not reduce student physical activity. It is not clear, nevertheless, whether their use can facilitate student learning the content specified in the curriculum.

2.3. Interest as a motivation source in physical education

Constructivist learning theory acknowledges that learner motivation is a key component in learning (Resnick & Klopfer, 1989). Among many motivation sources, interest has been considered powerful and effective in

engaging student during learning process (Dewey, 1913). In educational research, interest is conceptualized as situational and personal (Hidi, 1990, 2000). Situational interest refers to learners' psychological disposition that is triggered by environmental stimuli. Situational interest can have the immediate effect of engaging students in the learning process. Personal interest refers to learners' relatively enduring disposition based on personal value, belief, and knowledge. Personal interest is internally activated preference for an activity, whereas situational interest is often triggered by external stimuli.

In physical education, situational interest derives from multiple components associated with the content or context: novelty, challenge, exploration intention, instant enjoyment, and attention demand (Chen, Darst, & Pangrazi, 1999). Situational interest has been shown to positively influence both cognitive and physical engagement in physical education (Chen, Shen, Scrabis, & Tolley, 2002). Chen and colleagues (2002) found that situational interest had a relatively high predictability for students' in-class physical activity. However, no significant direct relation was found between students' skill and knowledge learning and situational interest (Shen, Chen, Tolley, & Scrabis, 2003). Shen et al. (2003) reasoned that the impact of situational interest on learning outcomes may be indirect, due to the fact that situational interest is a short-lived disposition. It can have a strong, immediate impact on student engagement during the learning process, rather than a direct long term effect on learning achievement.

In summary, although evidence seems to suggest the value of integrating intensive cognitive learning opportunities for nurturing student interest in physical education (Chen et al., 2007; Sun et al., 2008), our understanding of the relationship between interest, cognitive engagement, and learning achievement is still very limited (Solmon, 2006). Whether or not situational interest in physical education could lead to cognitive engagement and corresponding achievement remains unknown. Similarly the extent that students' cognitive engagement in completing workbook tasks contributed to achievement also remains unclear.

In this study, we examined the relationship between students' situational interest, their writing tasks through workbook, and their achievement in learning health-related fitness knowledge in elementary-school physical education. Based on the review of previous studies, we hypothesized that situational interest and the quality of cognitive engagement in the workbook tasks would contribute to their learning achievement. A hypothesized model in Fig.1 depicts the relations among them. Through testing this model, we intended to answer the following research questions: (a) does situational interest lead to corresponding cognitive engagement in intensive written tasks? (b) does situational interest and cognitive engagement in physical education enhance student achievement? and (c) how does successful completion or attempting to complete workbook tasks predict workbook score in physical education?

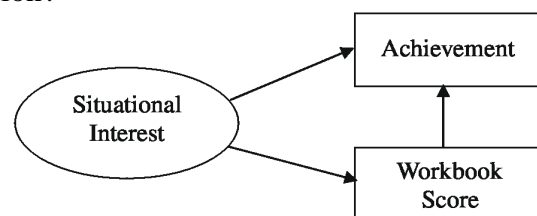


Fig. 1. The hypothesized latent path model.

3. Methods

To answer the research questions, we used a randomized correlational design within a large-scale curriculum intervention study involving a randomly-assigned experimental group (n =15) and a control group of schools (n =15). Teachers in the experimental group received training to teach a health-science based fitness education curriculum. Students in the experimental schools were instructed using the experimental curriculum that required them to use a student workbook in all 30 lessons to construct knowledge about health-related physical activities and their benefits. Teachers in the control group received a placebo training consisting of classroom management strategies. Their students were taught in a traditional, game centered multi-activity curriculum. Students in both groups were tested in cognitive knowledge about health-related physical activity (e.g., fitness components, benefits, effects of exercise on body systems) prior to and after the experimental curriculum intervention.

3.1. Participants

For the purpose of this study, we examined the data from third-grade students (N = 670) from 13 of the 15 experimental schools because the return rate of student workbook was very low in two experimental schools where the physical educators were reluctant and resisted using the workbook. The school sample was stratified based on socio-economic characteristics (e.g., FARM), and student performance on the State standardized science test. Within each experimental school the physical education teacher taught the intervention curriculum for all of his or her third through fifth grade students. The overall return rate of the 13 experimental schools included in the study was 84.91% for all data. The sample included 51.1% males, 1.6% students reported an Asian ethnic background, 64% African American, 7.3% Latino, 11% Caucasian, and 16.1% other backgrounds. The sample was representative of the elementary school student population in large urban areas in the United States at the time of the sampling (National Center for Education Statistics, 2003).

3.2. The research setting

The current study was part of a large physical education curriculum intervention study that examined the implementation of an externally designed science-based health-related fitness physical education curriculum. The larger research used a randomized, controlled clinical trial design involving an experimental condition with 15 schools and a control condition with 15 matching schools. Because the workbook was used only in the experimental condition, the data analyzed in this study came from the schools in the experimental condition.

3.2.1. The intervention curriculum

The intervention curriculum is a health science-enriched physical education curriculum that uses a hands-on, problem-solving approach to teach health-related fitness concepts in physical education. The curriculum primarily included three components: the Teacher's Manual, Student Science Journal (the workbook), and the Family Science Activity Night. The Teacher Manual includes 90 lessons sequenced in three units, "Dr. Love's Healthy Heart" (cardiorespiratory content), "Mickey's Mighty Muscles" (muscular strength & endurance) and "Flex Coolbody's Fitness Club" (flexibility, nutrition/caloric balance). Each unit includes 30 lessons, 10 for the third, fourth, and fifth grades each. In each physical education lesson students assume the role of "junior scientists" to conduct experiments examining the effects of exercise on their bodies. Each lesson is structured using the "5-E" scientific inquiry process as the framework to help learners construct meaningful knowledge. The five Es include: Engagement (set-induction and warm-up), Exploration (physical activity experiment), Explanation (understanding outcomes of physical activity), Elaboration (meaning making by apply knowledge and skills to life experiences), and Evaluation (concluding meaningfulness of the knowledge and skills learned; Balci, Cakiroglu, & Tekkaya, 2006). The "junior scientists" are physically active throughout each lesson using their personal responses to physical activity as science data in experiments. They record the data in their Student Science Journal (a 70 page workbook with questions to solve in each lesson), graph and calculate outcomes, answer questions, draw conclusions, and communicate their findings to others.

3.2.2. Student workbook

In this curricular approach, the student workbook is the central tool for students to use in constructing knowledge. Each student in the 15 experimental schools received a workbook for their personal use. The workbook was used in a variety of ways during the lesson. For example, students began the lesson by responding to a workbook challenge to predict their future performance or predict their bodies' physiological response to a particular activity, or intensity, or duration of the physical activity. Students set their workbooks aside while physically active with a task. They carried the workbooks with them when moving to different learning centers. Throughout a lesson the learner continued working on physical activity tasks, recording their data, and drawing conclusions. Several lessons guided students to summarize their findings using writing or graphing during the Evaluation segment of the lesson to reinforce the scientific principles and concepts being taught.

3.3. Variables and measures

For this study, we analyzed the third-grade students' workbook data from the cardio-respiratory fitness unit. As described in Fig. 1, we were interested in the relationship between three variables: interest-based motivation,

cognitive engagement, and achievement. Interest-based motivation was operationalized as students' perceived situational interest in the content learned through the unit as measured on the situational interest scale (Chen et al., 1999). Student achievement was operationalized as knowledge gain (either positive or negative) reflected in the difference between students' pre- and post-test performance on the standardized knowledge tests (Chen et al., 2006). Cognitive engagement was operationalized as student performance on the workbook that they used routinely in each lesson to document their thinking and decisions during scientific inquiry problem solving. The measure was validated for this study (see below).

3.3.1. Situational interest

Student situational interest was measured using three items validated for measuring the total situational interest in physical education experiences (Chen et al., 1999; Sun et al., 2008). The items are embedded in an 18-item situational interest scale completed by students that measured the total interest within the validating source dimensions of novelty, challenge, attention demand, exploration intention, and instant enjoyment (Sun et al., 2008). All items in the scale were randomly placed and attached to a 4-point Likert-type scale with written descriptors. The three total interest items were "My physical education classes are... very fun (4), somewhat fun (3), rather boring (2), very boring (1)" [Item 1]; "Activities in my physical education classes are... very attractive (4), somewhat attractive (3), rather dull (2), very dull (1)" [Item 2]; and "I am having fun in my physical education classes...everyday (4), most days (3), a few days (2), not at all (1)" [Item 3]. The construct validity of the situational interest scale was established using a factor analytical approach with structural factor loadings ranging from .78 to .99 (Sun et al., 2008). The structural reliability coefficient (ρ) for the scale is .87. The internal consistency reliability coefficients (Cronbach α) were reported to be .78, .80, .90, .91, .90, and .95 for the dimensions of Novelty, Challenge, Attention Demand, Exploration Intention, Instant Enjoyment, and Total Interest, respectively. These psychometric indicators suggest the scale can provide data with high measurement and structural validity and reliability.

3.3.2. Cognitive engagement

The quality of writing in workbooks reflects the depth of cognitive engagement (Mason, 2001). According to Chapman (2003), researchers have used students' workbook to examine cognitive engagement. In this study, cognitive engagement was measured by students' performance on 20 core questions embedded in routine questions throughout the workbook.

Each of the 20 questions went through a stringent validation process. The very first validation step is that the expert teachers on the curriculum writing team generated the questions, examined them for content validity, and determined their readability for the students. Secondly, five doctoral students trained as members of data analysis team for the larger study developed a set of rubrics to be used to evaluate students' answers to the 20 questions. Third, after the workbooks were completed, we took the following steps to validate the rubrics so that the score assigned to each answer reflects the level of understanding of the student (validity) and is consistent across different scorers (reliability).

We used the standard known-group method to accomplish the rubric validation. (a) We randomly selected one third-grade class from each school ($N = 228$) and divided students into quartiles using their scores on the standardized knowledge test, a summative measure of student achievement on the unit (explained in Student Achievement section). We named the top quartile as "Top Achieving" group ($n = 43$) and the bottom quartile as "Low Achieving" group ($n = 38$). (b) We then randomly selected 10 workbooks from each group. The five data analysts scored answers to all 20 questions in these 20 workbooks using the rubrics, without knowing the group identify of the workbooks (blind scoring). (c) Correlation analysis was conducted on all five scores for each answer for the top-achieving and low-achieving groups separately for inter-rater reliability. The inter-scorer correlation coefficients ranged from .87 to .94 for the Top Achieving group and from .98 to .99 for the low-achieving group. The results indicate that the rubrics can provide very consistent scores among trained scorers. (d) Using the rubrics, the analysts completed scoring all the workbooks in both groups. The discrimination index was computed for each question by comparing scores of an answer between the two groups using the following formula:

$$\frac{[(N \text{ correct in Top group}) - (N \text{ correct in Low group})]/\text{Total } N \text{ of either group} * 100\%}{}$$

We then used the conventional standard that any questions with a discrimination index of 40% or higher was determined as effective in distinguishing high achieving from low achieving (Morrow, Jackson, Disch, & Mood, 2005). The 20 indices of discrimination ranged from 38% to 76%, indicating that all 20 questions taken together, the scores based on the rubrics are effective in distinguishing students who have learned the content from those who have not. In other words, students' answers to the 20 questions are valid evidence that provides trustworthy information for the researchers to document the student cognitive engagement during the learning process. As can be seen in [Appendix A](#), the rubrics scores represent the amount of information relevant to the content knowledge being taught at the moment. As illustrated in [Appendix A](#), the scoring scale, can range from 0 up to 6 indicating the amount of cognitive engagement spent on processing the content information and responding to the question.

3.3.3. Student achievement

Student achievement was measured using knowledge gain scores calculated as the differences between students' pre- and post-test scores using the regression-residual approach (Zimmerman & Williams, 1982). The standardized cognitive knowledge tests were validated previously (Chen et al., 2006) to be the summative evaluation of student learning in the curriculum. The test items were constructed to reflect the core content of the cardiorespiratory fitness unit. For example, an item from the knowledge tests follows (the asterisk indicates the correct answer).

If you want your heart to beat faster, you should increase your:

- (a) physical activity frequency;
- * (b) physical activity intensity;
- (c) muscle strength.

When taking the pre and post test, students answered 14 questions in a standard multiple-choice format. Nine questions were the same across pre and post tests. Therefore only these nine questions were used to calculate student knowledge gain score. One point was assigned for each correct answer and a zero was assigned for each incorrect answer. An arithmetic sum of the total (correct) scores was computed as performance score for both pre and post tests, respectively.

3.4. Data collection

The pretest and posttest were administered either in quiet classrooms or gymnasias by physical education teachers before and after completing the cardio-respiratory fitness unit. Students' workbooks were used in each lesson and students were asked to complete the questions in the workbook using information gathered during physical activity. All workbooks were collected and returned to the researchers for analysis after the unit was completed. Since each unit of the curriculum included only 10 lessons and every lesson was structured in the same way using 5-E scientific inquiry process. In order to minimize students' burden and the potential negative effects of taking the same scale repetitively, the situational interest scale was administered during the last lesson of the unit. In the scale, students were asked to respond to the statements based on their experiences in the past 2 weeks in physical education.

3.5. Data reduction and analysis

The residual-adjusted gain score from the pretest to posttest were used to represent student achievement in the unit. The rubric scores from the 20 core questions in the workbook were summed and the total score was used to represent the quality of cognitive engagement during the learning process. Students' responses to each situational interest item were used as a direct measure in the subsequent structural equation modeling (SEM)

analysis to form the latent construct of situational interest. We used SEM to examine the theorized latent path model (see Fig. 1) for the relation among cognitive engagement during learning process, situational interest, and achievement. The SEM procedures were based on the analysis of covariance structures using the EQS[®] program (Bentler, 2005). We also conducted a series of hierarchical multiple regression analyses to examine the impact on student achievement when students did not complete the workbook questions and the impact of incorrect answers to the questions on the workbook score. In addition, we conducted a regression analysis with curve estimation to determine the interpretability of the results by seeking the best fit model.

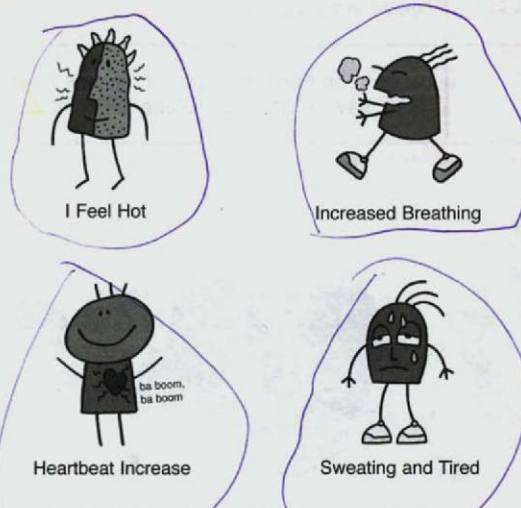
Appendix A

After you counted pulse for 6 s, what number did you add to the count to get your heartrate?—.

After you counted your **pulse** for six seconds, what number did you add to the count to get your **heartrate**?

Point	Scoring standard
1	“zero”, 0, or multiply by 10
0	Incorrect answer, or no answer (i.e., Not-attempted)

Circle the pictures that show the **physiological changes** that occurred in your body during the “Scrambled Eggs” **experiment**.



Point	Scoring standard
6	All answers circled
5	3 answers: increased breathing AND increased heartbeat AND another answer
4	2 answers (only): increased breathing AND increased heartbeat
4	3 answers: increased breathing OR increased heartbeat AND 2 other correct answer
3	2 answers: including increased breathing OR increased heartbeat AND another
2	1 answer: increased breathing OR increased heartbeat
2	2 answers: hot, sweating and tired, NOT increased breathing or increased heartbeat
1	1 answer: hot, sweating and tired, NOT increased breathing or increased heartbeat
0	No answers circled (i.e., Not-attempted)

4. Results

The primary goal of this study was to investigate the relation between students’ situational interest, their cognitive engagement in writing tasks through workbook, and their achievement in learning health-related fitness knowledge through testing the hypothesized structural model (Fig. 1). We were also interested in exploring the effects of situational interest, disengagement (not attempting cognitive written tasks), and answering incorrectly in the workbook on the performance of workbook score. The purpose here was to identify the extent to which these factors contributed to the total workbook score.

4.1. Descriptive statistics and data-model fit

To determine the model tenability for situational interest measure, we used the confirmatory factor analysis to verify the five source components. The result suggests that these five components were held well accounting for 95.4 percent of variability in total interest ($\chi^2=423.759$, $df=120$, $p < .01$; CFI = .925; SRMR = .041; RMSEA = .057). Reliability analysis result shows a sound structural reliability ($Rho \rho = .880$) for the situational interest scale. Thus it was determined that using total interest subscale only to indicate the level of situational interest was relevant and sound. Using a single indicator also helped minimize the complexity of the structural model (i.e., parsimony principle) in testing the hypothesized model. The internal consistency reliability coefficient for the Total Interest subscale appears to be adequate (Cronbach $\alpha = .713$).

Table 1
Descriptive Statistics for All Variables.

Variable	Mean	SD	Skewness	Kurtosis
Interest Item 1	3.49	.79	-1.89	3.13
Interest Item 2	3.39	.82	-1.41	1.27
Interest Item 3	3.29	.83	-1.10	.52
Workbook score	33.41	12.24	-.40	-.42
Achievement	.003	1.82	-.48	-.47

Table 2
Correlation coefficients for variables included in the model.

Variable	Interest Item 2	Interest Item 3	Workbook score	Achievement
Interest Item 1	.374**			
Interest Item 2	.503**	.478**		
Interest Item 3	.047	.074	.028	
Workbook score	.027	.126**	.073	.405**

** $p < 0.01$.

The descriptive statistics and correlation coefficients for all variables included in the hypothesized structural model are reported in Tables 1 and 2, respectively. It is clear that Kurtosis values were non-zero (see Table 1), thus we suspected the multivariate normality assumption for model testing was likely to be violated. Further analysis showed that Mardia's coefficient (Mardia, 1970) was 10.11, greater than the threshold of 5.00, suggesting that the assumption was not fully met. In this case, using conventional goodness-of-fit indices χ^2 , Comparative Fit Index (CFI), and root mean square error of approximation (RMSEA) might lead to problematic conclusions (Bentler, 2005). It is suggested (Satorra & Bentler, 1994) that the robust estimation with Satorra-Bentler χ^2 (S-B χ^2) and associated indices should be considered to prevent erroneous interpretations. As recommended by Hu and Bentler (1999), we followed these commonly-used cutoff criteria for the goodness-of-fit indices to determine the goodness of data-model fit: non-normed fit index (NNFI $\geq .95$), CFI $\geq .96$ and standardized root mean-square residual (SRMR $\leq .09$); or SRMR $\leq .09$ and RMSEA $\leq .06$.

Table 3
Results of multiple regression analysis (MRA; dependent variable: workbook score).

MRA	Predictor	Std. β	R^2
Model 1	Block 1	Not-attempted	-.81**
	Block 1	Incorrect	-.39**
Model 2	Block 1	Not-attempted	-.81**
	Block 2	Interest	Attention (-.06**)
			Challenge (.08**)
Model 3	Block 1	Incorrect	-.34**
	Block 2	Interest	Enjoyment (-.15**)

** $p < 0.01$.

Based upon Hu and Bentler cutoff criteria, the results of SEM analysis indicate that the model fit the data very well and could be interpreted meaningfully. The goodness-of-fit indices for the hypothesized structural model are as follows: S-B $\chi^2 = 7.337$ ($p = .119$), $df = 4$, NNFI = .982; SRMR = .022; RMSEA = .035, $CI_{90} = .000, .075$; CFI = .991. As presented in Fig. 2, the standardized path loadings were added to the structural model. The model explained four percent of variability in workbook score and 16.4% of knowledge gain, respectively. In addition, we also tested the alternative structural model using the five components to form the situational interest latent variable. As expected, the result of the alternative model appeared to be similar, however with poorer data-model fit: S-B $\chi^2 = 206.625$ ($p < .01$), $df = 100$, NNFI = .921; SRMR = .022; RMSEA = .042, $CI_{90} = .000, .044$; CFI = .942. The alternative model explained eight percent of variability in workbook score and 16.9% of knowledge gain, respectively, similar with the more parsimonious model (Fig. 2). Hence the more parsimonious model with better data-model fit is preserved for discussion.

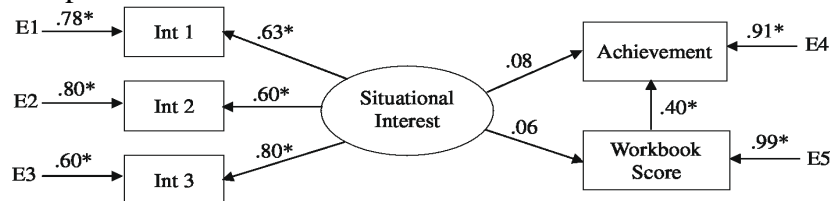


Fig. 2. The final latent path model (* $p < .05$).

4.2. Regression analyses

Using regression analysis, we examined three sets of hierarchical relations. The first relation explained the collective impact of not-attempted and incorrect answers in the workbook on the quality of cognitive engagement during learning process (workbook score). In this analysis, we entered the number of not-attempted and incorrect answers in the same block with the stepwise selection. As can be seen in Table 3, these two factors contributed largely to low performance in the workbook ($R^2 = .81$; $\beta = -.39$). In the second and the third analysis, the number of not-attempted and incorrect answers was entered in the first block alternatively and the five sources of Situational Interest were entered in the second block with stepwise selection. The number of not-attempted answers accounted for a much larger variance ($R^2 = .65$; $\beta = -.81$) than the situational interest sources to the workbook score, while the combination of incorrect answers and situational interest source dimensions contributed little.

Because the number of not-attempted questions was the primary determinant of student workbook score, we intended to better understand the relationship between not-attempted questions and workbook score. Using a trend analysis (regression curve estimation), we found that 47 students' workbook scores were identified as outliers and subsequently deleted because the outliers would render a problematic outcome. Results, as reported in Fig. 3, show that the number of not-attempted questions had a profound negative effect on student cognitive engagement during learning process, resulting in lower workbook scores. This finding is verified with both the exponential model (explaining 73.0% of the variability of workbook score) and the linear model (explaining 65.4% of the variability). These results lead to a conclusion that skipping answering questions in the workbook could tremendously influence achievement negatively.

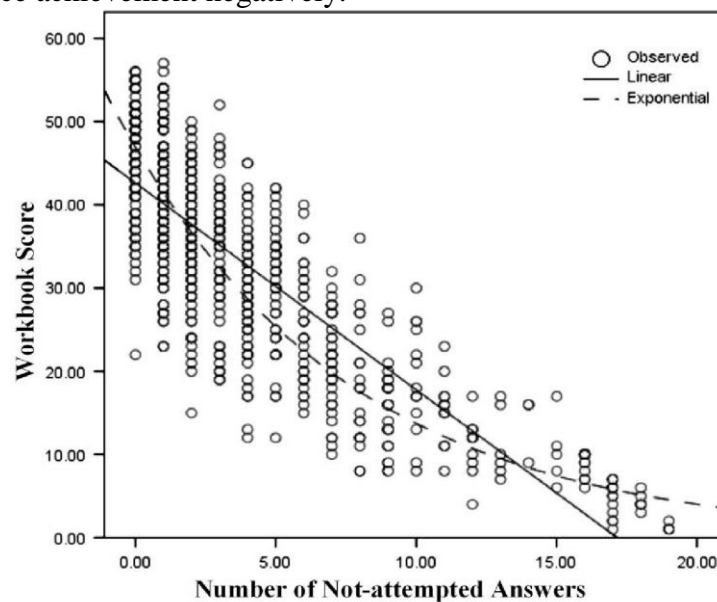


Fig. 3. Regression curve estimation of skipping on workbook score.

5. Discussion

The purpose of this study was to examine the relation between students' situational interest, cognitive engagement during learning process, and their achievement on health-related fitness knowledge in physical education. In general, the findings suggest that situational interest did not directly contribute to workbook score in the learning process or to achievement. Student cognitive engagement reflected as workbook score, however, contributed significantly to achievement indicated by knowledge gain. In addition, the findings indicate that cognitive knowledge achievement in physical education was enhanced by routine use of workbook tasks; and that skipping workbook questions had a worse impact on student achievement than answering the questions incorrectly.

5.1. Contribution of situational interest

The results of this study have painted an interesting picture for the role of situational interest in cognitive learning in physical education. The findings of non-significant effect observed in the latent path model (Fig. 2) partly confirms the findings reported earlier (Shen et al., 2003) that situational interest contributed little to stu-

dents' cognitive learning on skill-related knowledge in physical education. Considering research findings that situational interest has a positive impact on physical activity in physical education (Chen & Darst, 2001; Chen & Shen, 2004; Chen et al., 2006; Shen et al., 2003), the current findings seem to suggest that the role of situational interest in physical education seems to depend on the type of tasks that students are engaged in.

Based on the results of regression analyses, the five components of situational interest, novelty, challenge, attention demand, exploration intention, and instant enjoyment contributed little directly to student cognitive engagement in writing tasks. Three components, attention demand, challenge, and instant enjoyment entered into the regression models. Attention demand and instant enjoyment, however, were associated with negative β values, suggesting an inverted association with student workbook score. Although the R square values were minimal for these components, the β values of these components perplexed the researchers.

A plausible interpretation may be that situational interest is associated with students' expectation in physical education.

According to constructivist learning theory, students' previous experiences play an important role in their learning process. The previous experiences of physical education classes for students in this study were primarily sports and recreational games. When these students expect situational interest in physical education to be primarily derived from physical activity rather than cognitive activity, asking them to engage in cognitive tasks may diminish their perception of situational interest in physical education. This speculation is supported by an argument made by Alexander and Jetton (1996) that students' interest in a certain domain is highly related to their perception of importance of the domain. The absence of situational interest impact on the workbook score and achievement may demonstrate a possibility that students perceive physical tasks to be more important than cognitive tasks in physical education.

5.2. Importance of engagement

The path model in Fig. 2 indicates that student workbook performance contributed significantly to their achievement. This finding supports the commonly accepted notion in classroom research that students' cognitive engagement in learning process could lead to corresponding achievement (Greene & Miller, 1996). This finding seems to be particularly valuable in that cognitive learning in physical education can also lead to corresponding cognitive achievement. Similar results have been reported in reading (Cunningham, 1984) and mathematics (Cueto et al., 2006). It seems apparent that using the workbooks in the curriculum intervention created a learning environment where the students expected cognitive learning to take place with physical movement. This integrated learning experience contributed to their overall fitness knowledge growth.

It is important to notice that skipping workbook tasks contributed a significantly large portion of variance to low or no knowledge gain than did answering workbook questions incorrectly. Increases in skipping learning tasks predicted workbook scores decrease exponentially (see Fig. 3). It is not unusual that students often are unable to complete workbook assignments with high correct percentage rates. For example, Cueto et al. (2006) reported that sixth grade students were able to solve only about 44% of mathematics workbook tasks correctly. The results support the premise that correct performance in solving in-class cognitive problems is a reliable predictor for knowledge gain. Our findings suggest that merely engaging in the problem solving process could reduce the possibility of no achievement (i.e., knowledge gain). This finding is important in that it underlines the importance of cognitive engagement, suggesting that non-engagement may be the worst enemy of learning. Student cognitive engagement in attempting to solve problems, even when the answer is incorrect, is more likely to lead to achievement gains than non-engagement as represented by not attempting to answer the question. The findings indicate that any opportunities for students to engage in learning tasks will likely lead to desirable learning outcomes.

Using cognitively intensive writing tasks delivered in student workbooks in physical education is not a very common practice and at times can be controversial. The current study produced empirical evidence that reveals a positive, predictive relationship between intensive writing tasks in workbooks and knowledge gain.

Integrating routine cognitive tasks in physical education might be a viable strategy to increase student achievement, particular when mastery of cognitive knowledge is a learning goal in physical education (NASPE, 2004). The important relation between writing tasks in workbooks and achievement reported in this study may shed light on curriculum decisions in terms of the extent to which writing can be integrated as a practicable learning experience in physical education. Using workbooks as a delivery system of cognitive concepts to facilitate learning in health-related fitness knowledge may be a viable approach to help physical education claim its accountability in fulfilling the academic mission of schools, especially in the case where using workbooks in a carefully designed curricular context will not cost precious time for physical activity (Chen et al., 2007).

5.3. Directions for future research

A somewhat disappointing finding in this study is the weak relation between situational interest, cognitive engagement in writing tasks, and achievement. Situational interest was found contributing little to cognitive knowledge growth in a learning-oriented curriculum where students' cognitive learning was reinforced through physical activities. Although we reasoned that students' high expectation and common perception of "fun" in physical education contributed to the absence of a significant relation, this does not preclude a possibility that cognitively intensive tasks are not motivating in physical education or a mismatch to the subject matter that is centered on physical activity. Carefully designed experiment research is needed to clarify the role of situational interest in cognitive learning in physical education.

The measurement of situational interest could contribute in part to the non-significant paths between situational interest, cognitive engagement in writing tasks, and knowledge gain. The situational interest scale was developed and tested primarily in traditional physical education contexts where very few cognitive writing tasks took place (Chen, Darst, & Pangrazi, 2001; Chen et al., 1999). Even though the scale reported high internal reliability, it is possible that the situational interest scale was not sensitive to cognitive engagement especially writing tasks in physical education. Through a series of regression analyses, we found that directly using the five components of situational interest contributed little to the workbook score. Among the three components entered in the regression models, two of them were associated with negative β values. These negative β values further puzzled us regarding the relation between situational interest and cognitive tasks in physical education. More studies are needed to examine the origins of these sources in cognitive tasks in physical education and how they compose the fluid variable situational interest.

Although the result of using writing tasks to reinforce students' knowledge learning in physical education is promising, the challenge remains for physical education teachers in terms of integrating the use of workbook in physical education. Besides heavy teaching load and other administrative duties, physical education teachers normally have fewer resources than classroom teachers. The implementation of No Child Left Behind Act further marginalized physical education by reducing its instructional time. This makes physical education teachers feel more difficult to include workbook tasks, to grade workbooks, and to provide feedbacks to students than teachers in other disciplines such as mathematics (Cueto et al., 2006). Although our data suggest that providing students opportunities for completing the workbook can contribute to achievement, guiding students to correctly solve health-related fitness problems is the key to facilitate knowledge gain. Future research is needed to examine the effect of task completion and correct responses on achievement. Research is needed also to assess the impact of these different emphases on teacher lesson planning, interactive decisions during instruction.

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