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Original article

Learners' motivational response to the Science, PE, & Me! curriculum: A situational interest perspective

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Abstract

Background: The Science, PE, & Me! (SPEM) curriculum is a concept-based physical education curriculum that offers students coherent educational experiences for constructing health-related fitness knowledge through movement experiences. The purpose of this study was to evaluate students' motivational response to the SPEM curriculum from the situational interest perspective.
Methods: The study used a cluster randomized controlled design in which 30 elementary schools in one of the largest metropolitan areas in the eastern United States were randomly assigned to an experimental or comparison condition. Although all students in the 3rd, 4th, and 5th grades in the targeted schools were eligible to participate in the study, a random sample of students from the experimental ($n = 1749$; 15 schools) and comparison groups ($n = 1985$; 15 schools) provided data. Students' motivational response to the SPEM curriculum or comparison curriculum was measured using the previously validated Situational Interest Scale−Elementary. Data were analyzed using structural mean modeling.
Results: The results demonstrated that the experimental group (as reference group) showed significantly higher enjoyment ($z = -2.01$), challenge ($z = -6.54$), exploration ($z = -12.195$), novelty ($z = -8.80$), and attention demand ($z = -7.90$) than the comparison group.
Conclusion: The findings indicate that the SPEM curriculum created a more situationally interesting context for learning than the comparison physical education curriculum.

Keywords: Constructivist learning theory; Curriculum intervention; Elementary physical education; Learner motivation; Structural mean modeling

1. Introduction

Promoting youth physical activity (PA) and wellness in schools requires systematic efforts that center on physical education (PE) curriculum interventions.[1] PE is the main avenue in the school through which children and adolescents receive formal education about active living.[2,3] In particular, through K−12 PE, students are expected to become physically literate with knowledge, motivation, skill, and behavior development needed for life-long PA participation.[4] Some evidence-based PE curricula have shown significant effectiveness in fostering students with the competence and motivation that are essential for well-being and performance.[5,6] Of those evidence-based curricula, the Science, PE & Me! (SPEM) curriculum offers students coherent educational experiences designed to motivate them in constructing health-related fitness knowledge through carefully designed movement tasks.[6−8] The SPEM curriculum was also designed to raise learners' interest using situational interest as a major motivation strategy.[9] The purpose of this study was to evaluate elementary school students' response to situational interest in the SPEM curriculum.

1.1. Interest theory

Learners' motivation is defined as the process whereby goal-directed activity is instigated and sustained.[10] Motivation is a crucial determinant of student engagement and learning in PE,[11] which has been examined from a variety of theoretical lenses, including interest theory.[12,13] Interest is defined as the psychological state of engaging or willingness to reengage in

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specific content, which has a powerful influence on learning and engagement.[14] It is conceptualized to vary from situational interest to individual interest.[9,14] Situational interest refers to a psychological state that is elicited by certain aspects of the immediate environment, while individual interest refers to the relatively enduring predisposition to reengage particular content.[14] Interest can be developed following a 4-phase model that begins with triggered situational interest and then transforms into maintained situational interest, emerging or less developed individual interest, and ultimately the well-developed individual interest.[14,15] While individual interest takes a long time to change, situational interest is instantaneously changeable and domain specific, making it a useful motivation element to manipulate for curriculum and instruction deliberations.[9,14,16] For sustained engagement and learning, learners' situational interest triggered in the moment by environment stimuli must be maintained.[14] Maintained situational interest may be expressed in sustained feelings (perceiving the situation as enjoyable and engaging) and values (perceiving the situation as important and valuable), especially in secondary school students.[17] When maintained, situational interest can influence the growth trajectory of individual interest (i.e., emerging individual interest and well-developed individual interest).[15] Having a strong level of individual interest in a task, activity, or subject is educationally meaningful, because individual interest is internally driven and is always motivating.[14,18] Recent evidence further substantiates that a reverse relationship between individual interest and learning also exists, showing individual interest as a consequence of knowledge increase.[19] Therefore, examining learners' motivation from the perspective of interest theory has significant educational implications. Triggering and maintaining situational interest is a critical pedagogical strategy to immediately stimulate in-class engagement and learning and to develop individual interest in the long run.

1.2. Research on learners' interest in PE

Initial work on learners' interest in PE was conducted by Chen in 1996,[20] after which the body of literature on situational interest has grown tremendously. In a recent review, Chen and Wang[9] came to 2 conclusions concerning the utility of situational interest in PE. First, the conceptualizations of situational interest and its 5 sources (i.e., novelty, challenge, attention demand, exploration, and instant enjoyment) are well-substantiated by empirical evidence.[8,21–25] These 5 situational interest sources suggest that a learning task should (a) present new information that was unknown to the learner (i.e., novelty), (b) have optimal difficulty and be achievable through effort (i.e., challenge), (c) demand and draw the learner's attention (i.e., attention demand), (d) offer the learner the opportunity to discover and explore solutions (i.e., exploration), and (e) offer the learner a sense of delight (i.e., enjoyment). Situational interest can exert spontaneous, short-lived, and powerful motivation forces to drive learners for engagement and learning. To entice situational interest, a physical educator may make purposeful pedagogical manipulations on any of the 5 sources of situational interest. One of the motivational impacts of situational interest is its influence on facilitating physical engagement (captured by step count, energy expenditure, vector magnitude, and PA time) both in and outside of PE classes.[26–29] These 2 conclusions provide a theoretical foundation and practical strategies for guiding pedagogical manipulations that promote in-class engagement as well as overall PA participation. Physical educators are encouraged to make pedagogical manipulations in their curriculum to trigger and maintain students' situational interest and therefore facilitate engagement and learning.[9] Such pedagogical manipulations can target the 5 sources of situational interest: perceptions of novelty, challenge, attention demand, exploration, and instant enjoyment.[8,21,25] The design of the SPEM curriculum, for example, takes into account all 5 sources of situational interest as motivational elements so that students perceive their SPEM experience as attention demanding, challenging, explorative, enjoyable, and novel.

1.3. Research gap and purposes

Despite the plethora of research on situational interest as described, to our knowledge no large-scale curriculum intervention studies have examined the motivational response to the curriculum from the perspective of situational interest. SPEM is a multi-year PE curriculum intervention focused on teaching upper-elementary school students the knowledge and behaviors necessary for health-related fitness. Prior research has lent support to the efficacy of SPEM in increasing elementary school students' health-related fitness knowledge[7,30] while also keeping students physically active in class.[31] Importantly, SPEM lessons were designed to address the learners' motivational response to the curriculum experience by embedding the 5 situational interest sources in the tasks. It was assumed that this design would stimulate students' situational interest when they received the SPEM curriculum. However, this assumption has yet to be tested through empirical evidence. Therefore, the purpose of this study was to evaluate students' motivational response to the SPEM curriculum from the perspective of situational interest. It was hypothesized that students who experienced the SPEM curriculum would report higher scores on the measures of the 5 situational interest sources compared to those who did not experience the curriculum. The findings from this study advance our current understanding about the pedagogical significance of situational interest and its sources in curriculum design.

2. Methods

2.1. Research design

The data for this study stemmed from a large curriculum intervention research to develop, evaluate, and disseminate the SPEM curriculum. The PE teachers at the experimental schools implemented the SPEM curriculum after receiving a 3-day professional development for teaching the SPEM curriculum, while those in the comparison group also received a 3-day professional development, as placebo, on topics related to effective teaching strategies for the district-sanctioned curriculum. Teachers in both conditions received the same number of visitations/observations by the research team during the intervention period. Curriculum implementation fidelity for both conditions was monitored through field observation by trained graduate research assistants using standardized observation instruments.

2.1.1. *Power analysis*

The original study used a cluster randomized controlled trial design where a 2-level hierarchical linear model was established to guide the power analysis for sampling. The treatment effect is represented by the explained portion of variance by the explanatory variables at both student ($R_1{}^2$) and school ($R_2{}^2$) levels. These variances are expressed, respectively, as:

$$R_1{}^2 = \left(\mathrm{Y_{ij}} - \Sigma_{\mathrm{h}}\gamma_{\mathrm{h}}\mathrm{X_{hij}}\right)/\mathrm{Y_{ij}}$$

and

$$R_2^2 = 1 - \left(\mathrm{Y_{\cdot j}} - \Sigma_{\mathrm{h}}\gamma_{\mathrm{h}}\mathrm{X_{hj}}\right)/\mathrm{Y_{\cdot j}},$$

where $\Sigma_{\mathrm{h}}\gamma_{\mathrm{h}}\mathrm{X_{hij}}$ is the proportional mean square prediction error. The student-level average explained variance (R^2) from curriculum intervention studies in elementary school PE is 0.25. Given this information, we expect that the observed $R_1{}^2$ from this study would be at a similar magnitude. Using the effect size in the sample size calculation with 0.80 power at $\alpha = 0.05$, we determined that the student-level sample should include a minimum of 506 students (253 in each condition). In PE research, few studies provided sufficient effect size or mean and standard deviation information using school-level statistics.

2.1.2. *Sampling*

We randomly selected 30 elementary schools offering 3rd-, 4th-, and 5th-grade classes from the participating school district. In sampling, we grouped approximately 120 elementary schools in the district into 15 sampling brackets by matched-school socioeconomic status (free and reduced price meals rate) and school-level performance on the state standardized science test. Other factors considered in sampling included pupil/teacher ratio and enrollment size (National Center for Education Statistics; www.nces.gov). We next randomly selected 2 schools within each sampling bracket and randomly assigned them to either the experimental or comparison condition. The procedure resulted in 2 comparably equivalent groups.

2.1.3. *The sample*

The random sample of schools represented under-privileged schools in the urban areas of a major metropolitan area in the eastern United States. The sample had an ethnically diverse student population, with 8.4% of students being Hispanic or Latino and 70.1% being Black or African American, followed by White (18.7%) and other ethnic groups. The students were from the 3rd, 4th, and 5th grades in both the experimental schools ($n = 1749$; 15 schools) and comparison schools ($n = 1985$; 15 schools). They were representative of the student population in the metropolitan area. The Institutional Review Board of the University of Maryland approved the study. Written parental consent and minors' assent were obtained prior to the start of data collection.

2.2. *The SPEM curriculum vs. comparison curriculum*

The SPEM curriculum was designed by a team of master PE teachers, science education teachers, and university researchers.[7] Its development was guided by the principles of social constructivist learning theory[32,33] and the domain learning theory.[32] The theme of the curriculum is "learning science through physical activity" in addition to the situational interest perspective.[14,21] The curriculum affords students with abundant opportunities to conduct PA experiments as lived experiences to construct a deeper understanding of fitness, active living, and nutrition concepts. The curriculum includes three 10-lesson units for each grade. Dr. Love's Healthy Heart unit focuses on learning concepts of building and improving cardiorespiratory fitness and health, Mickey's Mighty Muscle focuses on muscular function and health, and Flex Coolbody's Fitness Club focuses on healthy flexibility and nutrition. In total, the SPEM curriculum consists of 90 lessons, 30 lessons for each of the 3rd, 4th, and 5th grades.[7] More important, each lesson is structured following a 5E instructional system (i.e., engagement, exploration, explanation, evaluation, and elaboration) in which the 5 sources of situational interest[8] are carefully cultivated. For example, each lesson begins with an engagement activity that is usually an exciting game used to induce instant enjoyment. An experiment activity follows, in which learning tasks enticing students' curiosity are given for them to explore their body's secret responses to exercise. In the elaboration activity, students conduct Think, Pair, Share tasks to continuously challenge themselves by learning from each other. A unique learning tool in SPEM is its companion student workbook. Upon completion of each task or experiment, students record the data/information related to their body responses to exercise, such as heart rate, estimated physical exertion, and repetition of weight lifting, in their personal workbook and then use the data to answer a variety of questions. The workbook tasks are structured in 3 levels of cognition: descriptive tasks, relational tasks, and reasoning tasks. The tasks in this structure gradually guide students to high cognitive attention, another source of situational interest,[8] and eventually contribute to student knowledge gain.[34]

Table 1 illustrates some examples of curricular manipulation on these constructs. To increase students' sense of novelty, the SPEM curriculum offers new PE games, activities, or tasks that may be perceived as novel. For example, a 5th-grade lesson within the Flex Coolbody unit provides students with the opportunity to Explore (i.e., the 2nd E of the 5E system) and compare different methods of throwing to understand the concept of range of motion and flexibility. Through bodily experiment, students realize the importance of using a full range of motion (which requires good flexibility) to throw effectively and then develop the skill of throwing. Challenge is represented by the difficulty level of a lesson or task appropriate to the students' abilities. A moderately challenging task

Table 1
Manipulations within the Science, PE, & Me! curriculum on situational interest sources.

Situational interest sources	Science, PE, & Me! curriculum manipulations
Attention (task that draws the learner's attention)	Each lesson involves students as "junior scientists" working in small groups or in pairs on the signal of "zip zap zing!" Students ought to stay attentive and engaged throughout the lesson to solve the problems documented in the student workbooks.
Challenge (task that has optimal difficulty and is achievable through effort)	All tasks and games are cognitively and physically challenging and developmentally appropriate. Students learn/use the health-related scientific vocabularies while working on physical activities that are related to scientific concepts.
Exploration (task that offers the learner opportunity to discover and explore solutions)	Each lesson has an exploration task or game as a warm-up, followed by a series of experiments conducted by the students as "junior scientists". The problems drive the curious "junior scientists" to discover solutions through sustained collaborative effort.
Enjoyment (task that offers the learner a sense of delight)	All curriculum content (e.g., engagement and elaboration tasks and games) was designed by a panel of master physical educators, science educators, and university researchers to be fun and enjoyable for boys and girls in the 3rd through 5th grades.
Novelty (task that presents new information that was unknown to the learner)	Each lesson offers students with new concepts and principles concerning health-related fitness and healthy living, novel games, and experiences. These learning-intensive lessons differ from games or team sports in traditional physical education classes.

provides most students with the opportunity to achieve success through effort. However, a task that is too difficult or too easy would not likely be perceived by most students as interesting.[16] The deliberations of the expert panel ensured that the lessons, activities, and tasks had the appropriate level of difficulty to sustain interest. Other than novelty and challenge, a situationally interesting task demands student attention and should be explorative and enjoyable. In each SPEM lesson, students act as curious junior scientists who must stay attentive to engage, explore, explain, and evaluate their ability to learn to solve the problems (i.e., explorative) documented in their student workbooks. They work in small groups or in pairs to construct knowledge of health-related fitness through peer socialization. As the junior scientists conduct their experiments, the teacher scaffolds the students' explorations through Elaboration of the concepts. Through socialization with peers and the teacher, students construct meaningful learning and close the zone of proximal development.[32,33] Last, another parameter of curriculum design for the SPEM curriculum is enjoyment. Fitness concepts are integrated in fun and active games or activities for enhanced kinesthetic experiences and learning achievement. Previous research has shown success in incorporating these 5 motivation constructs into curriculum and instruction to increase the students' situational interest.[30,35,36]

The comparison condition involved the use of the regular district-wide PE curriculum. It was a multi-activity curriculum that offered short instructional units (2−4 weeks each) of games, team and individual sports, and fitness activities. The lessons had no clear learning objectives, and student participation and behavior were the main basis for grading and student evaluation. The PE teachers mainly followed the direct teaching style, where the teacher directs and students follow. The teachers in the comparison schools also received a 3-day placebo training from the research team. The training was primarily focused on effective classroom management strategies, national and state standards, district requirements, and data collection protocols for the research project.

2.3. Instrumentation

Motivational response to the SPEM curriculum was measured using the Situational Interest Scale-Elementary (SIS-E).[8] While certain items may load relatively low in bi-factor analysis,[23] predominant evidence suggests that SIS-E is a valid instrument to measure situational interest and its underlying sources.[9] The SIS-E includes 15 items measuring the 5 constructs of situational interest sources: novelty, challenge, attention demand, exploration, and instant enjoyment (3 items per construct). For example, 1 item measuring exploration is phrased as "My PE classes made me become...". Possible choices to complete this statement are (a) very curious, (b) somewhat curious, (c) a little curious, or (d) not curious. Another item measuring attention demand is phrased as "My PE classes made me...". Possible choices included (a) very focused, (b) somewhat focused, (c) a little focused, or (d) not focused. Students were instructed to circle the answer that accurately described their perceptions of these situational interest sources. The SIS-E has been previously validated among 3rd-, 4th-, and 5th-grade student populations.[8] All 5 situational interest constructs demonstrated sound internal consistency reliability using the sample in this study (α ranged from 0.72 to 0.85 for comparison and from 0.74 to 0.88 for experiment).

2.4. Data collection

Data collection followed predetermined procedures according to the research design. Undergraduate and graduate students majoring in kinesiology, psychology, public health, or education were recruited to be data collectors. Three weeks before the project started, the data collectors received a standardized 6-h-long data collection training at a university laboratory and an online 2-h self-study training on human subject protection. All data collectors demonstrated sufficient competency and then were assigned to the schools in either condition to collect data following a predetermined schedule and research protocol. The SIS-E was distributed immediately after randomly selected lessons. The data collectors read each item aloud to students and answered questions students had. Students were instructed to respond to the SIS-E based on their experiences in their PE lessons and were asked to complete the scale independently. Completed SIS-E scales were then collected and returned to the laboratory for data entry, screening, and analysis.

2.5. Data analysis

To address the research purpose, we compared the students' perceived differences in situational interest in the SPEM ($n = 1749$) and comparison curriculum ($n = 1985$) conditions. Conceptually, the 5 sources of situational interest are latent variables and measured by multiple indicators. In latent variable systems, the measured variables or indicators are hypothesized to be linear combinations of factors/constructs plus error, and these indicators are correlated because they share the same underlying factors.[37] Given the nature of our research purpose, a structured means modeling (SMM) analysis is the most appropriate approach for evaluating between-group differences in latent situational interest variable means.[37] SMM is based on structural equation modeling, which is a large-sample technique that seeks to model the variables' mean structure and the covariance structure such that researchers can make inferences with respect to the populations' underlying construct means.[38] Specifically, we adopted the 3-step SMM[39] to examine latent group differences directly from the following observed item-level measures: (a) confirmatory factor analysis (CFA), (b) invariance testing, and (c) latent mean analysis.

In Step 1, we conducted a standard CFA to test the factorial tenability of situational interest in each group (i.e., experiment group *vs*. comparison group). The purpose of Step 1 was to ensure the data model fit for each group. In Step 2, we conducted the CFA multi-group analysis to examine factor invariance across the 2 groups. In Step 3, we utilized SMM to determine if students in the experimental and comparison conditions differed on latent means of the 5 situational interest sources. In Step 3, we needed to ensure the form of model was equivalent across groups. The factor intercepts were allowed to differ so that the latent factor means could differ.[39] If the model fit well in Step 3, we would be able to interpret the differences between latent factor means. Hu and Bentler's joint criteria[40] were used to determine the model data fit: comparative fit index (CFI) ≥ 0.95 and standardized root mean square residual (SRMR) ≤ 0.09; or SRMR ≤ 0.09 and root mean square error of approximation (RMSEA) ≤ 0.06.[40] In addition, we used the following formula to compute the estimated standardized effect size: $d = \frac{|M\hat{a}_{FSI}|}{\sqrt{C_{FSI}}}$ (C_{FSI} = pooled variance estimate of SI factors).[38,39] Maximal likelihood estimation was used to deal with potential missing data in the above analyses.

3. Results

3.1. Step 1: Single-group CFA

In situational interest theory, the observed measures (e.g., exciting, thinking, curious) are conceptualized to be effect indicators of underlining factors (e.g., attention, exploration, instant enjoyment). Therefore, the 1st step was to conduct a single-group CFA to determine whether the intended situational interest structure accounted for the covariance among the indicators. The descriptive results, including mean, standard deviation, and correlation coefficient, are presented in Tables 2−4. Skewness and kurtosis of the items range from −1.9086 to −0.0939 and from −1.1893 to −0.0595, respectively. Additionally, Mardia's test of multinormality supported normal distribution (statistic = 43.1633 $< p \times (p + 2) = 15 \times (15 + 2) = 255$). Students reported moderate composite average scores of the 5 sources of situational interest. The results of the CFA demonstrated a good data model fit for both the experimental group data—$\chi^2 = 198.921$ ($df = 80$, $p < 0.001$), SRMR = 0.027, CFI = 0.978, and RMSEA = 0.033 with 95% confidence interval (CI): 0.027−0.038—and for the comparison group data—$\chi^2 = 384.922$ ($df = 80$, $p < 0.001$), SRMR = 0.036, CFI = 0.956, and RMSEA = 0.05 with 95%CI of 0.045−0.055. The results also suggested that the 5-dimension situational interest model is tenable and replicable in both groups. Specifically, the Cronbach's α of the model was 0.86 for the experimental group data and 0.87 for the comparison group data, and the construct reliability coefficient (ρ) was 0.87 for the experimental group data and 0.88 for the comparison group data.

3.2. Step 2: CFA multi-group analysis

In Step 2, we used a multi-group CFA approach. Before we were able to evaluate differences in factor means, we assumed that the model structure of situational interest was equivalent across groups; that is, the model specified in Fig. 1 should fit for both SPEM and the comparison curriculum conditions. In Step 2, we also assumed that the values of model parameters were equivalent between groups.[41] Specifically, we conducted a sequential CFA multi-group analysis (a separate single-group CFA, 2-group model CFA, and multi-sample significance) to determine whether the situational interest model was invariant between the 2 groups. The single-group CFA results suggested

Table 2
Descriptive and latent mean results of the situational interest sources.

	Attention	Challenge	Exploration	Enjoyment	Novelty
Experimental	3.47 ± 0.61	2.64 ± 0.74	3.17 ± 0.70	3.25 ± 0.75	3.09 ± 0.75
Comparison	3.31 ± 0.66	2.45 ± 0.76	2.74 ± 0.79	3.22 ± 0.61	2.84 ± 0.80
Comparison (latent)	−0.225*	−0.142*	−0.322*	−0.057*	−0.253*

Note: Data are presented as mean ± SD or mean.
* $p < 0.05$.

Table 3
Correlation coefficients between the variables.

	Attention	Challenge	Exploration	Enjoyment	Novelty
Attention	–				
Challenge	0.35*	–			
Exploration	0.56*	0.44*	–		
Enjoyment	0.62*	0.33*	0.54*	–	
Novelty	0.57*	0.45*	0.63*	0.63*	–

* The correlation is significant at the 0.01 level (2-tailed).

Table 4
Correlation coefficients between the variables for the Science, PE, & Me! and comparison groups.

	Attention	Challenge	Exploration	Enjoyment	Novelty
Attention	–	0.38*	0.54*	0.65*	0.58*
Challenge	0.29*	–	0.47*	0.34*	0.47*
Exploration	0.56*	0.37*	–	0.52*	0.62*
Enjoyment	0.58*	0.32*	0.60*	–	0.63*
Novelty	0.55*	0.41*	0.60*	0.64*	–

Notes: Data below the diagonal refer to correlation coefficients for the Science, PE, & Me! curriculum group. Data above the diagonal refer to the correlation coefficients for the comparison curriculum group.
* The correlation is significant at the 0.01 level (2-tailed).

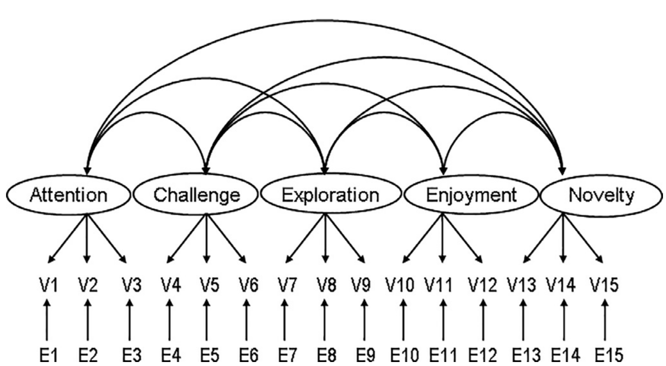

Fig. 1. The measurement model for the Situational Interest Scale-Elementary (SSI-E). V1–V15 represent the 15 SIS-E items, and E1–E15 represent the error terms. The one-way arrows from latent variables to observed variables (V1–V15) denote factor loading, while two-way arrows denote covariances across the latent variables.

that the model is tenable for each condition separately. The results from the 2-group CFA indicated that the 2-group model that tested data from both conditions simultaneously is tenable ($\chi^2 = 583.85$, $df = 160$, $p < 0.01$, CFI = 0.97, SRMR = 0.03, and RMSEA = 0.040 with 95%CI of 0.040–0.046). The multi-group CFA revealed that the difference between the model with loading constraints ($\chi^2 = 606.61$, $df = 175$, $p < 0.01$, CFI = 0.97, SRMR = 0.05, and RMSEA = 0.04 with 95%CI of 0.04–0.05) and the model without constraints was not statistically significant ($\Delta\chi^2 = 22.77$, $\Delta df = 15$, $p > 0.05$). Taken together, the multi-group CFA demonstrated measurement invariance of the situational interest model between the 2 conditions, suggesting that the SMM analysis may proceed.

3.3. Step 3: SMM analysis

Given the fact that the aforementioned CFA multi-group analysis showed a good measurement model between the 2 groups, we proceeded to the SMM analysis to address the purpose of the study: to evaluate elementary school students' response to situational interest in the SPEM curriculum. In this step, the factor intercepts were allowed to be variant between conditions so that the factor/latent means could differ if there was any difference. The SMM results showed that all latent means (Table 2) of the situational interest factors from the SPEM condition were significantly higher than means from the comparison condition ($z = -7.90$, -6.54, -12.195, -2.01, and -8.80 for attention, challenge, exploration, enjoyment, and novelty, respectively). Using attention for an example (Fig. 2), we assessed latent mean differences by using the experimental group as a reference group. The results suggest that the mean latent attention demand is significantly higher for the experimental group than for the comparison group (comparison mean = -0.225, $p < 0.05$), given the fact that intercepts are invariant across groups. The standardized effect size values suggested low to moderate practical significance ($d = 0.37$, 0.36, 0.63, 0.09, and 0.41 for attention, challenge, exploration, enjoyment, and novelty, respectively), all favoring the responses from the SPEM condition. These SMM results confirmed the intent of the SPEM curriculum development, which was designed to be situationally attractive and interesting. It is worth noting, however, that the standardized effect size should be higher than those found with measured variables because latent variables are error-free while the

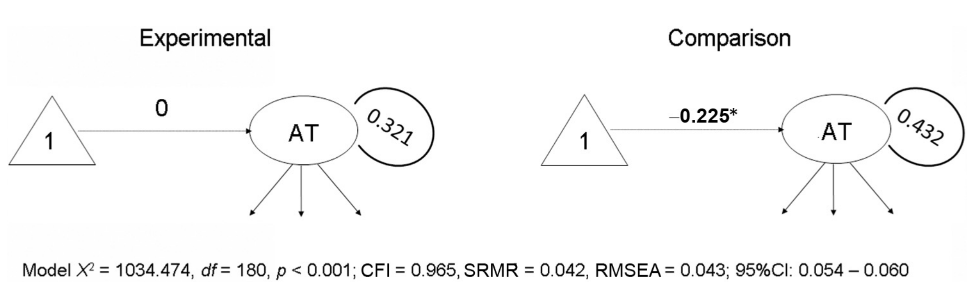

Fig. 2. The difference on mean latent attention demand (AT) between 2 groups. The fit results indicate that intercepts are invariant across groups. * $p < 0.005$, $d = 0.37$, and $z = -7.90$. CFI = comparative fit index; CI = confidence interval; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual.

measured variable allows for measurement error.[38] The standardized effect sizes in this study, therefore, are considered to be small, except for exploration, according to the cut-off points (0.23, 0.56, and 0.89 for small, medium, and large standardized latent effects, respectively).[38]

4. Discussion

The purpose of this study was to evaluate learners' motivational response to the SPEM curriculum from the perspective of situational interest. Following a cluster randomized controlled research design, our analysis attempted to identify the effect of the SPEM curriculum on students' situational interest. The results confirmed that the SPEM curriculum generated significantly higher situational interest than the comparison curriculum did. The findings add to the extant research literature by confirming the feasibility of manipulating curriculum factors to stimulate learners' situational interest in elementary school PE.

A key finding is that the students in the SPEM curriculum condition reported significantly higher situational interest than those in the comparison curriculum group. It has been observed occasionally in prior research that attention demand (e.g., increased demand of cognition) in PE can be a source of situational interest.[30,35] Physical educators are encouraged to exploit the opportunity to design tasks that trigger and maintain situational interest for the learner. Our finding provides evidence that the concept-based, knowledge-rich SPEM curriculum was perceived by the elementary school students to be more interesting than the comparison curriculum. One unique aspect of the SPEM curriculum is its 5E structure (i.e., engagement, exploration, explanation, elaboration, and evaluation) through which students cognitively engage as they perform movement tasks and activities in each lesson. The 5E structure enables the concept-based curriculum to be cognitively demanding, which is likely to be a main stimulating factor that entices student situational interest. This observation is in support of previous findings that reported an increase in situational interest when the PA tasks increased students' attention demand.[16,22]

It is noticeable that the students in the SPEM condition rated task novelty higher than students in the comparison condition did. This finding confirms that the SPEM curriculum offered students novel knowledge and experiences. The intentional focus of the curriculum on learning health-related fitness concepts through modified games and activities appears to make the learning experience novel in comparison with the traditional PE curriculum that the students in the comparison condition experienced. For instance, in the Dr. Love's Health Heart unit, students were guided by scaffolding tasks specified in the workbook to construct knowledge about cardiorespiratory endurance fitness through PAs such as running and jumping ropes. After each activity, students returned to the workbook to record their observations, analyze their physiological responses, and reach a conclusion about benefits from the activity. This seems to be more a novel task than merely participating in these activities without tangible purposes. This and other similar tasks about the scientific mechanisms underlying PA and movement participation seem to be sources of motivation that resulted in the informed association between PA and cognitive understanding among the young children.

Speculatively, it may not be an overreach to argue that a link between the physical and cognitive components of a learning task presents an opportunity for young learners to effectively bridge new cognitive information with their experiential repertoire developed mostly through physical activities. These tasks would possibly elevate and satisfy students' curiosity through novel experiences better than those tasks with a single focus on cognition or physical movement in the conventional curriculum. Engaging in these PA experiments and games associated with health-related knowledge does not demand a high level of sport skill proficiency and yet results in more instant enjoyment. This curriculum environment could be particularly friendly to students with an average or lower level of sport skills and could provide them with meaningful and enjoyable PA experiences and opportunities to learn knowledge beneficial for lifelong health.

While situational interest has been characterized as a short-lived, immediate engagement prompter,[14] a consistent lesson structure (such as the 5E in this study) coupled with comparable PA tasks tends to generate repeatable levels of situational interest.[42] Hidi and Renninger[14] proposed a theoretical hypothesis on interest development. One important component is the possibility of situational interest transition from a "trigger" phase to a "sustained" (or maintained) phase where individual interest, which is more stable and long-lasting, would start to emerge.[14] In a preliminary study, for instance, Zhu and Dragon[42] tracked students' situational interest through 5 consecutive lessons using the same lesson structure and comparable PA tasks, and their results showed that students reported a similar level of situational interest across those 5 PE lessons.[42] In other words, situational interest remained stable over multiple class periods. Because the SPEM curriculum used a consistent 5E structure for all lessons and students were expected to conduct experiments based on PA in every lesson, it is highly likely that the higher situational interest in the SPEM condition will be sustained throughout and across the units. Development of Individual interest relies on the development of knowledge and values.[14] Coupled with in-depth knowledge and values of PA as major content, the repeated exposure to situationally interesting tasks with knowledge and values assisted in the students' development of initial individual interest, which in turn led them to a stronger perception of situational interest in SPEM. This informed speculation, however, needs to be confirmed by future research.

In addition to the curricular level, at the instructional task level the integration of cognitive demand into teaching strategies is crucial in that higher cognitive demand also increases the level of the students' perceived situational interest.[16,22] Specifically, in the SPEM curriculum the Think, Pair, Share strategy and the workbook tasks add cognitive demands to the PAs and thus could be a contributing factor for the elevated situational interest reported in this study. As cautioned by Zhu and Chen,[16] adding cognitive demand, however, should depend on the cognitive demand level of the current task and the specific characteristics of the students. An overwhelming level of cognitive demand could potentially reduce participation and situational interest.[16] The findings of this study show a low to moderate level of situational interest in SPEM, which could have contributed to the significant knowledge gain that resulted from the SPEM curriculum intervention.[6]

Facilitating situational interest in PE has important implications.[9] In particular, situational interest has been shown to positively correlate with PA participation.[26,28,30] Thus, a curriculum with situationally interesting tasks is likely to contribute to a higher level of PA participation. In the case of the SPEM curriculum, a previous study demonstrated that students' PA levels during the lessons was not compromised in spite of their higher cognitive engagement and achievement compared to students in a regular PE curriculum.[31] The higher situational interest generated by the SPEM curriculum is likely to facilitate students' physical engagement, cognitive engagement, and knowledge achievement compared to a regular PE curriculum.

Due to the present study's cluster randomized controlled design and large random student sample, the findings reported here have added external validity, which increases generalizability of the findings. A motivated learner is the most effective learner, and interest in learning is the best guide for a learner. We encourage physical educators and teacher educators to incorporate the findings from this study into their daily teaching to increase situational interest. This includes deliberately changing the task structure, lesson organization, and even the entire curriculum.

Despite the strength added to our study by a randomized controlled design, we note the following limitations. First, we did not conduct a thorough manipulation check to investigate the extent to which the teachers followed the lesson plans during implementation. To address this concern prospectively, we sent trained data collectors to observe the implementation of the curriculum but we decided not to report these data because of significant missing data. Second, in our data analysis, we did not take into account potential moderating variables such as grade, gender, individual interest, or prior achievement in PE, because it was not our research purpose to test the curriculum effect caused by these variables. Future research should look into the potential group differences as they relate to these variables.

5. Conclusion

In addition to the findings from previous studies,[6,31] the findings in this study further support the value of the SPEM curriculum by verifying that the motivational component built into the curriculum generated positive results, as it was designed to do. Students in the experimental condition perceived the curriculum and learning to be more situationally interesting than their counterparts in the regular PE curriculum. The findings from this research, with its robust design, provide strong evidence suggesting that there are benefits to be gained from the dissemination of this evidence-based curriculum to other school districts within or beyond the original research site. To improve program scalability and implementation sustainability, such dissemination efforts should consider local adaptations to the curriculum based on feedback gathered before and during implementation through process evaluation.[43] More important, the findings clearly encourage physical educators to take advantages of situational interest to enhance students' physical engagement during PE classes. Our study has generated new information that is useful in guiding future curriculum design that facilitates positive student motivation, in-class engagement, and learning achievement. The implementation of the SPEM curriculum can be challenging, but through tailored staff training, PE teachers can successfully implement the curriculum into their schools.[44] Physical educators who are interested in teaching health-related fitness knowledge while maintaining students' interest and PA levels are encouraged to consider adopting the SPEM curriculum.

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Authors' contributions

SC drafted and revised the paper; HS helped collect and analyze the data; XZ helped collect the data; AC and CDE conceived and oversaw the project. All authors made significant contributions to the draft and revision of the paper. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

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