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Effects of teachers' participation in continuing professional development on students' perceived physical literacy, motivation and enjoyment of physical activity

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ABSTRACT

Physical education continuous professional development (PE-CPD) has been vaunted as a powerful influence on teachers' professional competence and subsequent student learning. Despite this proposition, there remains limited empirical evidence for the effect of teacher participation in CPD on student learning outcomes. In light of this void, the purpose of this study was to examine the influence of an eight-month PE-CPD program on students' perceived physical literacy, motivation and enjoyment of physical education. A randomized control trial design was used to assign a sample of 65 physical education teachers from Hong Kong to the CPD and control intervention groups. Students' (n = 1,485) perceived physical literacy, motivation and enjoyment of physical education measures were collected across three phases of the program (post-program, eight-month follow-up, and 14-month follow-up). Repeated measures ANOVAs were conducted to analyze changes in student learning outcomes across the three phases of the intervention. Results revealed low significant interaction effects of perceived physical literacy, motivation, and enjoyment across time depending on the participation level in CPD. The findings of this study provide an important addition to the extant literature on CPD, by revealing that teachers' commitment to participation in professional development may have a sustained influence on student affective learning outcomes.

Efectos de la participación del profesorado en el desarrollo profesional continuo sobre la percepción de la alfabetización física de los estudiantes, la motivación y el disfrute de la actividad física

Palabras clave:
Desarrollo profesional continuo
Alfabetización física
Motivación
Disfrute
Actividad física

RESUMEN

El desarrollo profesional continuo de la educación física (PE-CPD) se ha considerado una poderosa influencia en la competencia profesional del profesorado y en el posterior aprendizaje del alumnado. A pesar de esta propuesta, sigue habiendo pocas pruebas empíricas del efecto de la participación del profesorado en el PE-CPD en los resultados de aprendizaje del alumnado. A la luz de este vacío, el propósito de este estudio ha sido examinar la influencia de un programa de PE-CPD de ocho meses de duración en la percepción de los estudiantes de la alfabetización física, la motivación y el disfrute de la educación física. Se ha utilizado un diseño de ensayo de control aleatorio para asignar una muestra de 65 profesores de educación física de Hong Kong a los grupos de intervención de PE-CPD y de control. Las medidas de alfabetización física percibida por los estudiantes (n = 1.485), la motivación y el disfrute de la educación física se han recogido a lo largo de tres fases del programa (post-programa, seguimiento de ocho meses

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y seguimiento de 14 meses). Se han realizado ANOVAs de medidas repetidas para analizar los cambios en los resultados de aprendizaje de los estudiantes en las tres fases de la intervención. Los resultados han revelado efectos de interacción poco significativos de la alfabetización física percibida, la motivación y el disfrute a lo largo del tiempo en función del nivel de participación en el PE-CPD. Los resultados de este estudio aportan una importante adición a la literatura existente sobre PE-CPD, al revelar que el compromiso del profesorado con la participación en el desarrollo profesional puede tener una influencia sostenida en los resultados del aprendizaje afectivo de los estudiantes.

Introduction

The United Nations Educational, Scientific and Cultural Organization asserted that quality physical education should be a core part of the school curriculum and teachers' continuing professional development (CPD) should be integral to any national quality physical education strategy (McLennan & Thompson, 2015). Armour et al. (2017) proposed that physical education continuing professional development (PE-CPD) is needed to nurture and protect the career-long growth of teachers as learners who are able to cultivate the growth of students. They also suggested that effective CPD should include eight key elements if it is to connect to student learning: (1) include analyses of student learning, especially the examination of differences between actual student learning outcomes and goals and standards for student learning; (2) involve teachers identifying their own training needs and developing learning experiences to meet those needs; (3) be school-based and embedded in teachers' daily work; (4) organized around teachers' collaborative problem solving; (5) include follow up and support for future learning; (6) use multiple sources of evaluation data detailing student learning and teacher instructional practices; (7) the provision of opportunities for teachers to link the theory that underlines knowledge and skills they are learning; and (8) connect to a comprehensive change process focused upon improved student learning (Armour & Yelling, 2004).

Physical education teachers have reciprocated the potential benefit of PE-CPD as a vehicle for improving their professional competence in facilitating student learning (Sum et al., 2018). For CPD to be effective requires physical educators to have a commitment to the process and to take responsibility for working diligently towards their professional growth. If teachers remain committed to CPD, there are potential positive effects on both teachers' professional learning and the development of student outcomes (Timperley et al., 2007). Despite this potential, there remains a dearth of empirical evidence to validate the claim that participation in CPD has a positive, sustained effect on student learning outcomes. If education agencies are going to invest the time and money needed to provide CPD, then there needs to be evidence of a meaningful return on this investment. Within this study, these returns are conceptualized in terms of the physical education teachers' commitment to participation in the CPD process, and the consequential student learning outcomes of perceived physical literacy, motivation and enjoyment of physical education. The following discussion provides an exploration of these teacher processes and student outcomes of a PE-CPD program that underpins the study design.

Teachers' participation in CPD

Professional development remains an ongoing expectation and commitment as long as teachers remain within their chosen profession. Day and Gu (2007) argued that professional development at different stages of the teacher's life interacts with other factors to influence their dedication to the profession (Day & Gu, 2007). Teachers' participation in CPD can result in positive changes in teaching behaviors (Watson, 2006) and a greater willingness to differentiate instruction (Dixon et al., 2014). CPD has also been shown to have a positive impact on teachers' sense of commitment and their relationships with students (Goodall et al., 2005). Despite the potential for professional growth, teachers' commitment to the process of CPD is influenced not only by their own dedication and motivation for teaching but also by personal and family factors that impact their working life (Wan, 2013). Day et al. (2005) suggested that for experienced teachers to engage in CPD they need to have a perceived work-life balance such that they can increase their commitment to their professional development and career (Day et al., 2005). A commonly perceived benefit of participation in CPD is the increased potential for promotion and income (Crockett, 2010). However, as a consequence of CPD participation, teachers also value the opportunities to meet and share ideas with colleagues and to have more interaction with them (Deglau & O'Sullivan, 2006). How teachers balance the perceived costs and benefits of CPD to maintain their participation remains a rarely discussed topic, however, initial evidence suggests that the level of participation would likely impact student learning outcomes (Timperley et al., 2007). This study therefore explores the effects of teachers' participation in the CPD program as a key process variable in understanding students' learning outcomes.

Students' physical literacy

The concept of students' physical literacy has created a theoretical underpinning for a global trend of promoting healthy lifestyles for students (Flemons et al., 2018; Li, Sit et al., 2021). Physical literacy is defined as the motivation, confidence, knowledge and understanding to value and take responsibility for engagement in physical activities for life (Whitehead, 2019b). Physical literacy has permeated into global physical education policy by providing the conceptual backbone of quality physical education (McLennan & Thompson, 2015). As a result, numerous countries have revised physical education standards and implemented curricular programs targeting the development of students' physical literacy. In this sense, students' physical literacy has become a primary focus for the global aspirations of quality physical education. Physical education teachers are integral to the operationalization of physical literacy within curricular programs. As a result, developing teachers' knowledge of how to deliver programs that focus on the development of student's physical literacy has become a core element of CPD programming (McLennan & Thompson, 2015; Sum et al., 2018; Whitehead, 2010). The focus of this CPD has been to give teachers' the curricular and instructional tools to help students develop appropriate skills and strategies for moving within a specific environment and to understand how this affects their choices to be physically active across other movement contexts. The development of physical literacy remains an important outcome of students' physical education experience and requires further examination within the contexts of the teachers as active practitioners, the child as an active learner, and schools and the curriculum as providing active contexts (Whitehead, 2010).

Students' motivation and enjoyment

Self-determination theory serves as an empirically based, validated framework to explain students' adoption of physical activity behaviors (Ryan & Deci, 2017). It is potentially a viable framework from which to understand student experiences in physical education and develop interventions that could enhance student motivation toward physical activity (Vasconcellos et al., 2020). This framework is premised on a continuum of regulations based on autonomous (or self-determined) and controlled (or non-self-determined) motivation. Autonomous motivation is characterized by people being engaged in an activity with a full sense of willingness, volition, and choice (Deci et al., 2017). Physical education provides an opportunity for students to move towards more intrinsically regulated motives for physical activity through the satisfaction of the basic psychological needs of perceived competence, relatedness and autonomy (Deci et al., 2017). However, extrinsically motivated activities can, under the right circumstances, also be autonomously motivated—that is, engaged with authenticity and vitality (Deci et al., 2017). Research has shown that the pedagogical strategies used by the teacher and the subsequent motivational climate created in physical education are positively associated with students' motivation for physical activity through the satisfaction of these needs (Ryan & Deci, 2017). Students are more intrinsically motivated when they perceive that physical education fulfills these needs and enjoy contributing effort during classes. More internalized forms of student motivation in physical education have also been found to be positively related to students' level of participation and enjoyment of physical education and intention to participate in physical activity outside of school (Vasconcellos et al., 2020). Therefore, physical education programs that provide a motivational climate that satisfies students' three basic psychological needs are likely to foster an increase in student physical activity behavior (Ryan & Deci, 2017).

Theoretical model for CPD programs

The current study is aligned with a pedagogical model for Health-based physical education for its theoretical framework and research design (Haerens et al., 2011). Health-based physical education has been worked as the pivotal pedagogical model within physical education, as it supports one basic goal for all the other more popular pedagogical models, which is to help students develop healthy lifestyles far beyond the school requirements (Fernandez-Rio, 2016). This matches the ultimate goal of physical education – to develop students' physical literacy throughout the lifespan as it emphasizes "valuing the physically active life" within their programs (Haerens et al., 2011, p. 328). Previous PE-CPD programs that have focused on physical literacy have included a needs assessment phase to enhance teachers' knowledge and operationalization of physical literacy (Edwards et al., 2019). Previous CPD interventions have rarely adopted the Health-based physical education model as a framework for design and implementation. A recent study examined teachers' experiences during the CPD program and the subsequent impact on their pedagogical practice (Sammon, 2019). The findings of the study demonstrated mixed success when adopting a Health-based physical education model for teachers' CPD and connecting to students' out-of-class physical activities. Previous pedagogical models, such as Sport Education, have been shown to operationalize and develop students' physical literacy (Farias et al, 2019; Hastie & Wallhead, 2015). Therefore, the purpose of this study was to use the Health-based physical education model as an overarching framework to develop a CPD program that employed evidence-based, student centered pedagogies to develop students physical literacy, motivation and enjoyment of physical education.

The present research

If teachers are to maintain pace with the ongoing focus on developing physically literate graduates of physical education programs they must first come to understand the key attributes of physical literacy. Teachers must then be provided with a repertoire of pedagogical strategies that they can use to operationalize these attributes in the gymnasium. These strategies should not only afford the development of students' movement competency but also their motivation to capitalize on these innate characteristics to adopt a physically active lifestyle (Whitehead, 2019a). Developing these competencies requires teachers to engage in sustained professional development that prioritizes student-centered pedagogies that are likely to foster student movement competency and motivation. In many regions of the world, including Asia, there has been a minimal attempt to embrace the broader concept of physical literacy as a product of physical education and specifically the level of professional development required to operationalize this vision. This study represents an attempt to address this void by providing an 8-month CPD program to PE teachers in Hong Kong and examining the impact of the program on students' perceived physical literacy, motivation and enjoyment of the physical activity.

Method

Participants

Teacher participants

The research team sent a series of initial recruitment e-mail messages to all primary and secondary school physical education teachers who had a history of accessing CPD services at the TCS (Training Calendar System 2.1) of the Education Bureau in Hong Kong. Eligibility criteria for teacher participation in the PE-CPD program included: (1) currently employed as a full-time physical education teacher, and (2) no history of participation in any PE-CPD in the past three years. Sample size calculations for each group within the randomized controlled trial design were based on previous PE-CPD research in Hong Kong (Sum et al., 2016), assuming a 5% type I error (α) and 80% power. It was estimated that 25 participants per intervention group were needed. Sixty-five teacher participants were recruited and were stratified by gender and school levels (primary/secondary) before being randomly allocated via a computer-generated randomization sequence (GraphPad Software, Inc.) into one of the two groups (intervention and control) by a statistician who was blind to the purposes of the study. Teachers were notified by e-mail and telephone regarding their respective group placements. Participants in the CPD group were invited to attend a free, eight-month PE-CPD program. Teacher participants in the control group received no formal professional development. All teacher participants were asked to facilitate the collection of three phases of student data collection over 14 months following the completion of the 8-month CPD program. A total of 45 (23 CPD, 22 control) teachers completed all phases of student data collection.

Student participants

Three intact physical education classes from each of the teacher participants' schools were randomly selected as student participants. Students were required to complete a survey at three-time points following the completion of the PE-CPD program. The required cognitive level of the surveys (in English) restricted the random selection of classes in primary schools to only senior-aged primary school students. The number of student participants

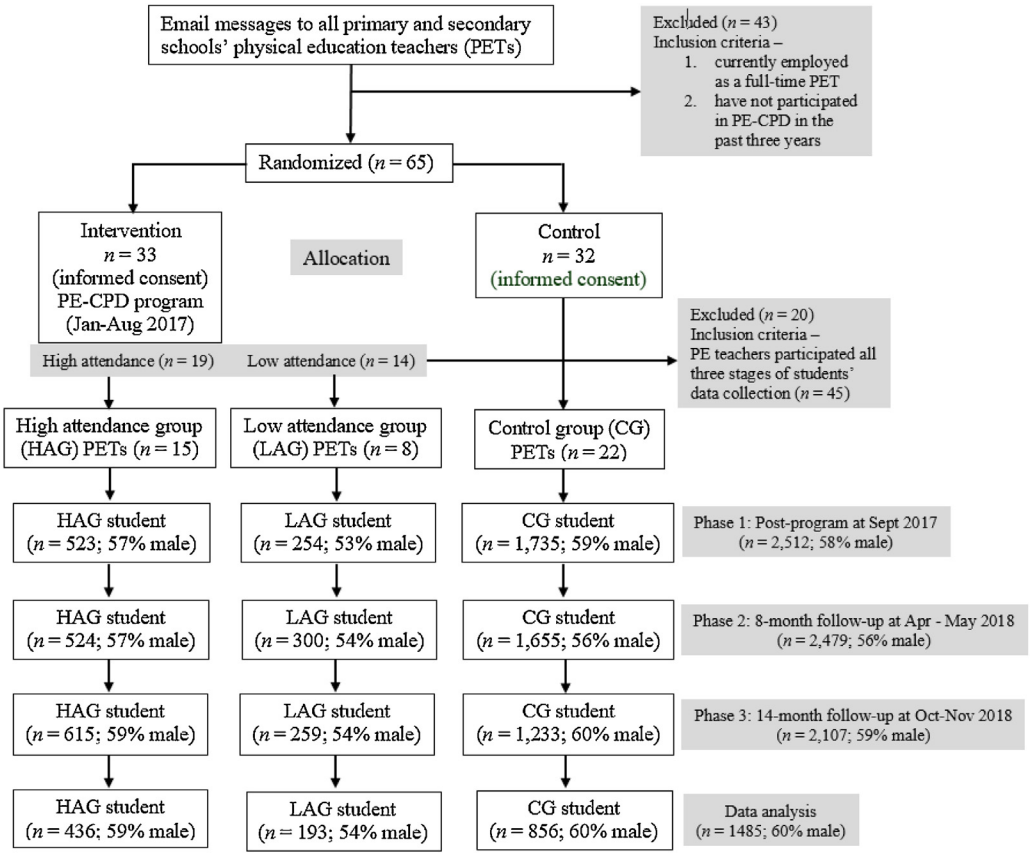


Figure 1. Flow diagram of participants completion of study data collection.

that completed all three phases of survey completion at post-program, eight-month follow-up and fourteen-month follow-up were $n = 2{,}512$, $n = 2{,}479$, $n = 2{,}107$ respectively. Details of the flow of the number of participants throughout the phases of the study are shown in Figure 1.

Instruments

Perceived Physical Literacy Inventory (PPLI)

PPLI is a validated and reliable 9-item survey instrument used to measure *perceived physical literacy* (Sum et al., 2016). The instrument is made up of three sub-scales representing the physical literacy attributes of *knowledge and understanding*, *sense of self and self-confidence*, and *self-expression and communication with others* (Whitehead, 2010). Participants respond to each item on a 1 to 5 Likert scale (1 = strongly disagree to 5 = strongly agree). Example items included: (a) I am aware of the benefits of sports-related to health (*knowledge and understanding);* (b) I am physically fit in accordance to my age *(sense of self and self-confidence)*; (c) I have strong social skills *(self-expression and communication with others)*. The instruments showed that model fit statistics were all adequate as follows: chi-square (χ^2/df = 9.598, $p < .001$), GFI = .96, RMSEA = .08, SRMR = .05, CFI = .95, IFI = .97, NFI = .95, and all models have satisfactory values on fit indices. The factor loading of all items ranged from 0.48 to 0.74, suggesting that observed variables sufficiently represented the latent variables (Hu & Bentler, 1999). Moreover, the factor loadings of all items were greater than 0.45 and in a consistent direction (*self and self-confidence*: CR = .70, AVE = .44; *self-expression and communication with others*: CR = .63, AVE = .36; *knowledge and understanding*: CR = .65, AVE = .39), representing an adequate convergent validity.

Situational Intrinsic Motivational Scale (SIMS)

SIMS is a 16-item survey instrument designed to measure participants' situational self-determined *motivation* while performing physical activity. SIMS carries four behavioral sub-scales including, *amotivation, external regulation, identified regulation, and intrinsic motivation* (Guay et al., 2000). Participants respond to items on a 1 to 7 Likert scale (1 = not at all true to 7 = very true) based upon the stem, "I participate in physical activity because…": (a) this activity is fun *(intrinsic motivation)*; (b) I believe this activity is important for me *(identified regulation)*; (c) I don't have any choice *(external regulation)*; and (d) I do this activity, but I am not sure it is a good thing to pursue it *(amotivation)*. The higher the score the higher the *motivation* and task interest. The SIMS instruments showed that model fit statistics were all adequate as follows: chi-square (χ^2/df = 16.84, $p < .001$), GFI = .87, RMSEA = .11, SRMR = .08, CFI = .89, IFI = .89, NFI = .86, and all models have satisfactory values on fit indices. The observed variables sufficiently represented the latent variables which the factor loading of all items ranged from 0.48 to 0.78 (Hu & Bentler, 1999). Additionally, adequate convergent validity was found that all items were in a compatible direction and the factor loadings were greater than 0.45 (*intrinsic motivation*: CR = .81, AVE = .51; *identified regulation*: CR = .67, AVE = .35; *external regulation*: CR = .64, AVE = .35; *amotivation*: CR = .63, AVE = .31).

Physical Activity Enjoyment Scale (PACES)

PACES is designed to assess how much a student enjoys participating in physical activity. Participants respond to the 16-item instrument on a 5-point Likert scale (1 = disagree a lot to 5 = agree a lot). Nine items are positive such as "I find it pleasurable", and "It gives me energy". Seven items are negative such as "I dislike it", and "It is not fun at all". Participants who receive high scores on positive items and low scores on negative items would indicate a high

enjoyment of the physical activity. The SIMS instruments showed that the factor loading of all items ranged from 0.62 to 0.89, suggesting that observed variables sufficiently represented the latent variables (Hu & Bentler, 1999). The factor loadings of positive items (CR = .91, AVE = .53) and negative items (CR = .94, AVE = .70) were greater than 0.45 and in a coherent direction, representing an adequate convergent validity.

Procedure

Ethical approval to conduct the study was obtained from the Survey and Behavioral Research Ethics Committee of the first author's institution. Phase one (post-program) of student data collection commenced following the teachers' completion of the eight-month PE-CPD program. Data collection included three randomly selected classes of students from each school completing a survey designed to assess their *perceived physical literacy*, motivation and *enjoyment* of the physical activity. The research team distributed the survey to student participants during their physical education lessons. Phase two of data collection occurred eight months following the CPD teachers applying the pedagogical strategies taught within the professional development program within their physical education curriculum. To assess implementation fidelity, all teachers video-recorded three sample physical education lessons for each of the three intact classes of student participants. All the recorded teaching episodes were sent to the research team for fidelity analysis for compliance with specific pedagogical benchmarks associated with the models of instruction (e.g. Sport Education, Teaching Games for Understanding). Following the eight-month intervention period, student participants were requested to complete the survey to assess their *perceived physical literacy*, *motivation* and *enjoyment* of the physical activity. Phase three of data collection occurred fourteen months following the completion of the PE-CPD program and students completed the same survey items for the third time.

Intervention program

Table 1 illustrates details of the PE-CPD program which was designed to enhance teacher participants' understanding of Health-Based Physical Education and to develop pedagogical strategies that targeted students' physical literacy (Sum et al., 2018). The PE-CPD program was a collaborative design of CPD materials in accordance with participants' needs and the attributes of physical literacy (Sum et al., 2021). The key strategies of the PE-CPD program included the infusion of pedagogical models and strategies that have been validated to operationalize key attributes of physical literacy. The CPD workshop provided background information on the Health-Based Physical Education model and emphasized the importance of each domain of physical literacy (physical, cognitive, affective and behavioral). Teacher participants were provided with opportunities to practice the learned skills and participated in discussions throughout the CPD workshop.

Data analysis

Data processing and analysis were completed in three stages. During stage one, in the instruments, we confirmed the three measures' reliability, by evaluating the factor loading of each of the items, the values of composite reliability (CR) and the average variance extracted (AVE) of the three instruments (Bagozzi & Yi, 1988). Moreover, the model goodness-of-fit was assessed by using chi-square, comparative fit index (CFI), goodness of fit index (GFI), incremental fit index (IFI), normal fit index (NFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). The model can be considered as a good fit if the cut-off value of CFI > 0.9, GFI > 0.8, IFI > 0.8, NFI > 0.8, RMSEA < 0.08 and SRMR < 0.05 were indicated (Hu & Bentler, 1999).

During stage two, data were initially screened for outliers and distribution assumptions were examined. Internal consistency estimates were calculated for all student survey variables. Teacher attendance at the PE-CPD program workshops varied considerably across the teacher participants. Fourteen teachers from the PE-CPD group attended less than 50% of the professional development program workshops. To co-factor the level of teacher participation within the PE-CPD program on student learning outcomes, teachers (and their students) were sub-separated into two groups based upon the threshold of attendance at 50% of the CPD workshops. The resultant three groups were a high participation group (HPG; teacher $n = 15$, student $n = 436$), low participation group (LPG; teacher $n = 8$, student $n = 193$) and control group (teacher $n = 22$, student $n = 856$). Teacher-participants attending more than 50% (25 hours or above) of the PE-CPD were regarded as HPG. Whereas, teacher-participants attending less than 50% (24.5 hours or below) of the PE-CPD were regarded as LPG.

During stage three of data analysis, descriptive statistics were computed for all students' demographic variables of age and gender for all three groups. A series of one-way analyses of variance (ANOVA) was conducted to determine any differences across groups in student learning outcomes of *perceived physical literacy*, *motivation,* and *enjoyment* of physical activity at baseline to examine if there were differences between groups at phase one. A series of two-way mixed-design ANOVA was completed opted to examine each outcome across groups and time phases. Post-hoc Scheffe and *least significant difference* (LSD) analyses were used according to ANOVAs and mixed ANOVAs respectively to discover contributing factors to significant F values. All data were analyzed using the Statistical Package for the Social Sciences (version 20.0; SPSS Inc., Chicago, IL). The significance level was set at a 95% confidence interval for all analyses.

Results

A total of 2,512 student participants completed the questionnaire in phase one, which dropped to 2,479 student participants in phase two and 2,107 in phase three. Correspondingly, Mahalanobis distance analysis (Hair et al., 2010) identified 622 multivariate outliers and a total of 1,485 valid responses were analyzed. Descriptive statistics for student scores of the overall *perceived physical literacy*, *motivation*, and *enjoyment* for each group at each time phase are shown in Table 2.

One-way ANOVA revealed significant differences between groups at phase one mean scores of each variable as shown in Table 3. In the current findings, the *Scheffe* test indicated that the scores of *perceived physical literacy*, $F(2, 1482) = 32.83$, $MS = 14.16$, $p < .001$, $\eta p^2 = 0.01$, *motivation,* $F(2, 1482) = 19.39$, $MS = 8.45$, $p < .001$, $\eta p^2 = 0.03$, and *enjoyment*, $F(2, 1482) = 14.95$, $MS = 1.4$, $p < .001$, $\eta p^2 = 0.01$ among HPG and LPG were higher than the control group at phase one. There was no difference between the two participation groups in phase one.

Mixed ANOVAs and corresponding post-hoc LSD tests illustrated significant interaction group x time effects of all variables as presented in Table 4. There were significant interaction effects ($p < .001$) between the groups across time phases on *perceived physical literacy*, $F(4, 2964) = 6.6$, $MS = 1.54$, $p < .001$, *motivation*, $F(4, 2964) = 3.56$, $MS = 0.96$, $p < .01$, and *enjoyment*, $F(4, 2964) = 7.78$, $MS = 0.58$, $p < .001$. Specifically, this indicates that these variables had different effects depending on the teachers' level of participation in CPD over the period.

Students' scores for *perceived physical literacy* and *motivation* over the three-time points are depicted in Figures 2 and 3

Table 1
Eight-month PE-CPD program

Date	Time	Content
21/1/2018	Morning 4 hours	Theory Course: Introduction of Health-Based Physical Education and physical literacy Practical: Somatic stretching
7/2/2018	Evening 3.5 hours	Theory Course: Sports injuries Practical: Sports taping
25/2/2018	Morning 4 hours	Theory Course: Legal liability in physical education lessons Practical: High-Intensity Interval Training – Physical literacy approach
7/3/2018	Evening 3.5 hours	Theory Course: Special education needs Practical: Teaching movement through games and activities
25/3/2018	Morning 4 hours	Theory Course: Know your body: Chiropractic perspectives Practical: Chiropractic and spinal health care
8/4/2018	Morning 4 hours	Theory Course: Teaching Games for Understanding Practical: Teaching Games for Understanding
22/4/2018	Morning 4 hours	Theory Course: Long Term Athletic Development - Talent identification and development Practical: Sports massage – Know your body
13/5/2018	Morning 4 hours	Theory Course: Sport Education and physical literacy Practical: Sports Education – Physical literacy approach
23/5/2018	Evening 3.5 hours	Theory Course: Insurance issues Practical: Rope skipping – Physical literacy approach
6/6/2018	Evening 3.5 hours	Theory Course: Enhancing physical literacy - Technology in physical education Practical: Kinball – Physical literacy approach
17/6/2018	Morning 4 hours	Theory Course: Role of Parent and Teacher Association in promoting an active school culture Practical: Light volleyball – Physical literacy approach
27/6/2018	Evening 3.5 hours	Theory Course: Action research in promoting health-based physical education and physical literacy
29/7/2018	Morning 2 hours	Teachers sharing and discussion on school-based curriculum development
29/8/2018	Evening 2 hours	Roundup, project debrief and interview to evaluate CPD workshop implementation

Table 2
Descriptive statistics for key student outcomes

Variable	*Mean* Phase one	*SD*	*Mean* Phase two	*SD*	*Mean* Phase three	*SD*
High participation group (n = 436)						
Physical Literacy	4.02	0.69	4.02	0.69	3.95	0.70
Motivation	4.97	0.69	4.97	0.69	4.85	0.71
Enjoyment	3.19	0.29	3.19	0.29	3.19	0.40
Low participation group (n = 193)						
Physical Literacy	3.97	0.63	3.97	0.63	3.80	0.70
Motivation	4.91	0.66	4.91	0.66	4.77	0.76
Enjoyment	3.24	0.33	3.24	0.33	3.22	0.40
Control group (n = 856)						
Physical Literacy	3.73	0.65	3.82	0.67	3.80	0.69
Motivation	4.74	0.65	4.85	0.68	4.75	0.66
Enjoyment	3.12	0.31	3.21	0.31	3.22	0.35

Note. SD = standard deviation.

Table 3
ANOVAs of variables for different groups at phase one

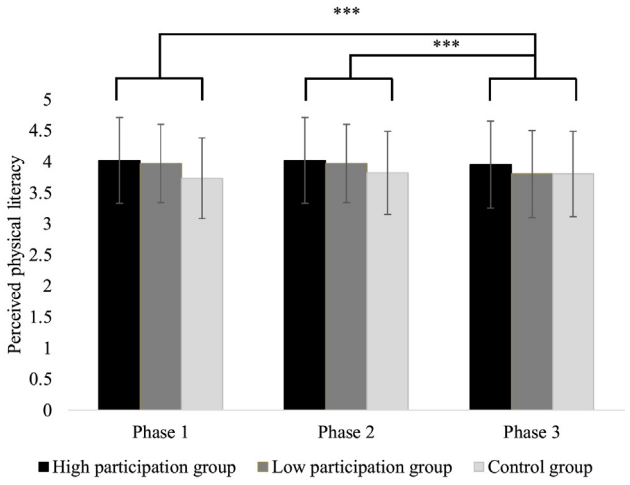
Source	*SS*	*df*	MS	*F*	ηp^2	*Scheffe's*
Perceived physical literacy						
Among groups	28.32	2	14.16	32.83***	0.01	1 > 3, 2 > 3
Error	639.26	1482	0.43			
Amounts	667.58	1484				
Motivation						
Among groups	16.89	2	8.45	19.39***	0.03	1 > 3, 2 > 3
Error	645.44	1482	0.44			
Amounts	662.33					
Enjoyment						
Among groups	2.80	2	1.40	14.95***	0.01	1 > 3, 2 > 3
Error	138.69	1482	0.09			
Amounts	141.49					

Note. SS = sum of squares; *df* = degrees of freedom; *MS* = mean squares; *F* = F ratio; ηp^2 = partial eta squared; ***p < .001; 1 = high participation group; 2 = low participation group; 3 = control group.

Table 4
Two-way mixed design of variables for different groups

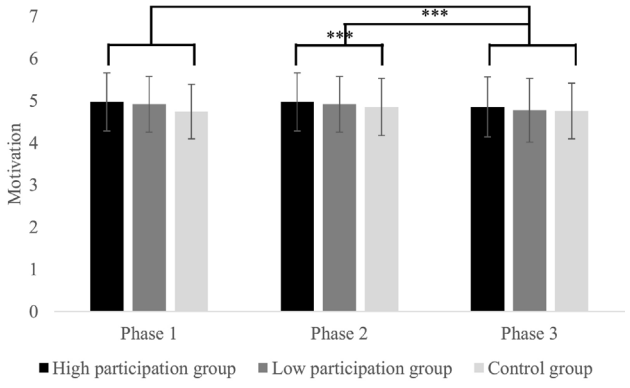
Source	*SS*	*df*	*MS*	*F*	ηp^2	*LSD*
Among groups	42.71	2	21.35	23.84***	0.03	
Among group error	1327.46	1482	0.90			
Perceived physical literacy	3.93	2	1.97	8.45***	0.01	1 > 3, 2 > 3
Among groups * within	6.14	4	1.54	6.60***	0.01	
Within error	689.39	2964	0.23			
Among groups	20.59	2	10.30	12.37***	0.02	
Among group error	1233.62	1482	0.83			
Motivation	7.33	2	3.66	13.61***	0.01	1 > 3, 2 > 3
Among groups * within	3.84	4	0.96	3.56**	0.01	
Within error	798.01	2964	0.27			
Among groups	1.08	2	0.54	3.08*	0.00	
Among group error	260.30	1482	0.18			
Enjoyment	0.57	2	0.28	3.81*	0.00	2 > 1, 3 > 1
Among groups * within	2.31	4	0.58	7.78***	0.01	
Within error	219.83	2964	0.07			

Note. *SS* = sum of squares; *df* = degrees of freedom; *MS* = mean squares; *F* = F ratio; ηp^2 = effect size; *LSD* = least significant difference; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$; 1 = phase one; 2 = phase two; 3 = phase three.



Note. ***$p < .001$.

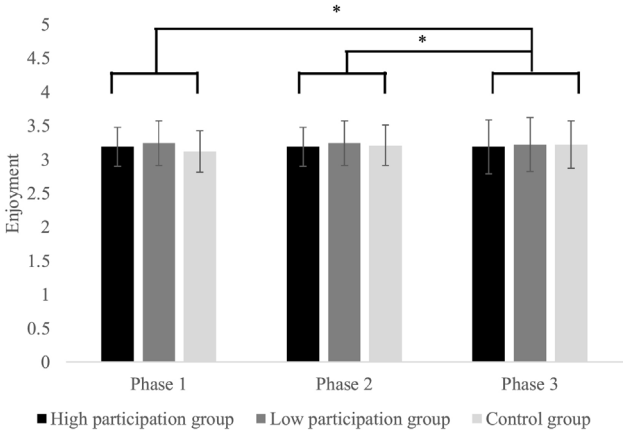
Figure 2. Longitudinal plots of students' perceived physical literacy over three phases.
Note. ***$p < .001$.



Note. ***$p < .001$.

Figure 3. Longitudinal plots of students' motivation over three phases.
Note. ***$p < .001$.

respectively. These figures illustrate that the student scores of the HPG group were significantly greater than the LPG and control group across time phases. Furthermore, the time effects of both variables in phase one and phase two were significantly higher



Note. *$p < .05$.

Figure 4. Longitudinal plots of students' enjoyment over three phases.
Note. *$p < .05$.

than that in phase three significantly, but no difference was found in the first two phases.

Figure 4 illustrates the student scores for *enjoyment* over the three-time points. The contrasts revealed that students in the LPG attained significantly higher scores than the HPG and control group across all phases. Results revealed that student perceived *enjoyment* was higher for the HPG and LPG at phase one with no differences between groups in phases two and three.

Concerning the specification in PACES, the time effect of *enjoyment* was further investigated by splitting the variables of positive and negative *enjoyment* through one-way ANOVAs at each time point. The results demonstrated significant differences on *positive*, $F(2, 1482) = 31.46$, $MS = 11.91$, $p < .001$ and *negative*, $F(2, 1482) = 35.48$, $MS = 16.91$, $p < .001$ *enjoyment* as shown in Table 5. Given that no differences were found in phase one and phase three, the scores of *positive enjoyment* in phase two were higher than that in phase one and phase three but vice versa for *negative enjoyment*. These analyses revealed small effect sizes ($\eta p^2 = .01$).

Discussion

The purpose of this study was to investigate the effects of teachers' participation in PE-CPD as guided by the Health-based Physical Education model on students' perceived physical literacy,

Table 5
Two-way mixed design of students' enjoyment

Source	*SS*	*df*	*MS*	*F*	*LSD*
Among groups	23.82	2	11.91	31.46***	
Among group error	16830.46	1482	16830.46		
Positive enjoyment	23.82	2	11.91	31.46***	2 > 1, 2 > 3
Within error	584.81	1484	0.38		
Among groups	33.84	2	16.92	35.48***	
Among group error	4428.37	1482	4428.37		
Negative enjoyment	33.84	2	16.91	35.48***	1 > 2, 3 > 2
Within error	740.47	1484	0.47		

Note. *SS* = sum of squares; *df* = degrees of freedom; *MS* = mean squares; *F* = F ratio; *LSD* = least significant difference; ***$p < .001$; 1 = phase one; 2 = phase two; 3 = phase three.

motivation and enjoyment of the physical activity. Results revealed that teachers in the high participation group had significantly higher scores on their students' perceived physical literacy, motivation and enjoyment of physical activity than their counterparts in the low participation group and control groups fourteen months following the completion of the PE-CPD program.

Physical literacy is a mechanism by which students can develop their confidence and motivation to engage in a physically active life journey (Green et al., 2018). In this study, the longitudinal effects of both participation groups on students' perceived physical literacy were higher than the control group. Previous research has found a positive relationship between perceived physical literacy and physical activity level among children (Li et al., 2020) and adolescents (Choi et al., 2018), and also a reverse pathway has been identified (Li, Sum et al., 2021). Although a small effect size was found in this study, physical education remains one of the key learning areas that provides teachers with the opportunity to foster a learning environment that nurtures the development of students' physical literacy. Physical education teachers need to be cognizant that creating structured lessons that use student-centered pedagogies has the potential to maintain and enhance student physical activity levels better than free choice periods (Li, Sit et al., 2021; Lonsdale et al., 2009). Altering the content and employing pedagogical strategies that foster physical literacy as the goal of physical education provides the potential to address the needs of all students in developing their sense of physical self (Roetert & MacDonald, 2015). Despite this potential, Capel and Whitehead's (2015) argument that physical education teachers may know about the concept of physical literacy pedagogical enactment of this type of curriculum may make it difficult to get the concept of physical literacy across to students. Choi et al. (2018) reflected that physical literacy is a new concept and physical education teachers may not have received sufficient professional development to operationalize the concept in short sport-skills focused lessons (Choi et al., 2018). The findings of this study suggest that the provision of CPD related to pedagogical models that align with the attributes of physical literacy provide greater alignment with the intended learning outcomes and the consequential growth and maintenance of students' perceived physical literacy.

Findings from the analysis of student motivation over the phases of data collection revealed that students from both participation teacher groups had significantly higher scores on student situational motivation in physical education than the control groups. As Green et al. (2018) stated this situational motivation reflects "motivation to be proactive in taking part in physical activity, applying self to physical activity tasks with interest and enthusiasm and persevering through challenging situations in physical activity environments" (p. 277). It is worth noting the important role that physical education teachers play in providing feedback, imposed goals, and needs satisfaction (Ryan & Deci, 2000) which influence students' self-determined motivation in physical education. Robinson and Randall (2017) reinforced the critical role of student intrinsic motivation in fostering students' physical activity, specifically that "confidence and physical competence are related to the belief in one's own ability to effectively use and apply a variety of general, refined, and specific movement patterns" (p. 42).

Although the study did not include the assessment of the level of physical activity, Lonsdale et al. (2009) found that self-determined motivation is associated with higher physical activity levels during structured physical education lessons (Lonsdale et al., 2009). A higher level of self-determined motivation in physical education is thus likely to elicit a concomitant behavioral change in student physical activity (Standage et al., 2005). In addition, when examining the growth trajectories of physical activity and enjoyment students who have higher levels of intrinsic motivation and moderate to high levels of extrinsic motivation report higher levels of enjoyment (Yli-Piipari et al., 2012). Enjoyment as an affective consequence of physical education has received attention as it has been predictive of a variety of behaviors such as learning and engagement (Garn et al., 2017) and can be an important positive motive for physical activity behavior (Hashim et al., 2008). In this study, students in the high participation teacher group had significantly higher scores of positive physical activity enjoyment and lower scores of negative physical activity enjoyment than both the low participation and control groups. This result is aligned with previous research that has shown that intrinsic motivation has a positive relationship with enjoyment, knowledge and performance in physical education (Gråstén & Watt, 2017). In contrast, students with lower enjoyment scores have been reported as having lower self-efficacy when participating in physical activity (Hu et al., 2007). The patterns of data from this study provide supplemental support to the assertion that PE-CPD can be effective in increasing the enjoyment of students when participating in physical education (Burns et al., 2017).

Limitations

Despite the rigor associated with the randomized controlled trial and longitudinal design, there are potential limitations to the analyses conducted. Although the pattern of data revealed that fourteen months following the CPD program the students in the high participation group reported significantly higher scores for perceived physical literacy, motivation and enjoyment the research team did not perform association analyses between variables. Considering the attributes of physical literacy (knowledge and understanding, sense of self and self-confidence, and self-expression and communication with others), we recognize that students' perception of their physical literacy may have influenced student motivation and physical activity enjoyment. This analysis decision was made based upon the resultant uneven distribution of student sample size across the three groups. Teacher participation in the eight-month PE-CPD program was lower than expected while the drop-out rate of teacher participants was surprisingly high. This teacher attrition supports previous literature which has shown a high drop-out rate of teachers from CPD because of the

challenges associated with freeing participants to attend programs (Halton et al., 2015). To improve this situation, CPD should be job-embedded (Wright et al., 2020) and consider teachers' "personal and professional needs, individual learning preferences, and input regarding what and how they will learn" (p. 177) (Hunzicker, 2011). Webster-Wright (2009) also stated that professional development for teachers requires flexible, accessible, and supportive practices, and time frames and activities tailored to suit their existing capacities and contexts (Webster-Wright, 2009). The in-service physical education teachers participating in the study were required to fulfill 150 hours of CPD in a consecutive 3-year period, however, it seems that government policies should consider all PE-CPD activities offered by the Teacher Education Institutes to be prioritized when compared with other professional development activities.

Conclusions

This study provides a valuable addition to the extant literature on PE-CPD. The randomized controlled trial and longitudinal nature of the research design provide some initial robust empirical evidence that students who received a physical education curriculum from teachers who consistently attended an eight-month CPD program based on Health-based physical education reported significantly higher levels of perceived physical literacy, motivation and enjoyment of the physical activity. This study thus provides an important first step in validating the efficacy of CPD in developing physical education curriculum programs that foster increased physical literacy. Green et al. (2018) noted that physical literacy is a principle to encourages self-awareness through embodied interaction with the environment and "should not be assessed through normative comparisons, absolute standards, or how well a child can replicate skills in games' (p. 276). The use of self-report measures to examine the perception of students' physical literacy, motivation and enjoyment was aligned with this conceptualization.

Findings suggest that the teachers that adhered to the CPD program increased their knowledge and operationalization of physical literacy (Edwards et al., 2019). The commitment to CPD opportunities seems to play a crucial role in students' learning outcomes. Physical education teachers' professionalism in terms of their professional growth, and innate characteristics of enthusiasm and willingness to apply learned skills were crucial in influencing students' perceived physical literacy, motivation and enjoyment. Future PE-CPD programs should focus on not only meeting expectations of a changing curriculum (Thorburn et al., 2019), and prioritizing contextual and contemporary challenges (Armour et al., 2017), but also should focus on physical education teachers' engagement and commitment to the CPD process. The present study highlights a pressing need for PE-CPD that supports teachers' understanding of how to operationalize physical literacy and gives them the efficacy to deliver a high-quality physical education curriculum.

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