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Research article

Predictors of Physical Activity Levels in University Physical Education Implementing Sport Education

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Abstract

By adopting Sport Education into the university context, this study examined how lesson content and teacher interaction contribute to university students' physical activity levels during physical education lessons. Following a continuing professional development workshop, a 10-week Sport Education season was designed collaboratively and implemented at a university, taking into account the university's facilities. This study used the momentary time sampling tool, System for Observing Fitness Instruction Time, in which eight teachers and 202 students (72% male) were videotaped in 156 lessons. The data on physical activity levels, lesson content, and teacher behavior were collected and analyzed. The student-participants engaged in an average of 38.77 (±18.78) moderate-to-vigorous physical activity (MVPA) minutes which did not meet the recommendation of 50% lesson time. Findings of hierarchical linear regression indicated that knowledge (β = 0.29) and general content (β = 0.29) contributed to the sitting physical activity while skill practices (β = 0.25) and gameplay (β = 0.38) predicted the MVPA. Practical implications of utilizing the features of Sport Education in boosting the intensity of activities are discussed, especially team affiliation, formal competition, and record keeping. Further investigations are proposed on the interaction of gameplay content and teacher behavior with larger sample size.

Key words: Physical education, sport education, physical activity, SOFIT, physical literacy.

Introduction

The World Health Organization (WHO)'s Physical Activity Guidelines (2010) recommended adults aged 18-64 to participate in moderate- and vigorous-intensity activities for at least 150 and 75 minutes per week respectively, where the duration of these can be increased up to 300 and 150 minutes in a progressive manner. On top of that, adults should also practice muscle-strengthening activities that involve major muscle groups for at least one day in their weekly repertoire. In Hong Kong, since 2012, the Behavioral Risk Factor Survey has been used to analyze the physical activity levels of varying age groups on a biannual basis. Their recent survey showed that about half of the adults aged 18-24 and those who graduated from university failed to attain the WHO's physical activity guideline (Department of Health, 2017). Such a decline in physical activity levels may be a result of life transition from secondary to university education (Condello et al., 2017; Dinger et al., 2014; Molina-Garcia et al., 2015).

The percentage of students participating in physical education courses as part of graduation requirements has been reduced in the higher education sector over the past 150 years (Cardinal, 2017). Academic stress, loads, and commitments are some of the perceived barriers for university students to participate in physical activities, as referred to by relevant studies (Thomas et al., 2019). In fact, a structured university physical education, physical activity, and health promotion program can increase students' motivation for life, optimize their perceived health (McBride and Xiang, 2013), and also reduce negative emotions (Annesi et al., 2017). Students who receive physical education at university are also more likely to demonstrate positive perceptions toward social life and have better stress resilience (Beaudoin et al., 2018; Jenkins et al., 2006). Given the strengths of university physical education, however, only one university in Hong Kong is adopting the Department of Health's (2010) policies at the time of writing.

Sport Education is a curriculum and instructional model which aims to develop students as sports players with competent, literate, and enthusiastic qualities (Siedentop et al., 2019). Its features include seasons, affiliation, formal competition, culminating event, record keeping, and festivity. Students can also gain authentic sports experiences through the devolved responsibilities of specific roles within a persisting team. This model aligns with The International Charter of Physical Education and Sport (United Nations Educational, Scientific and Cultural Organization, 2015) and Quality Physical Education (McLennan and Thompson, 2015) in valuing education through sports, such as fairness, team building, equality, discipline, inclusion, perseverance, and respect. Earlier systematic reviews revealed that most sport education studies were conducted in the sectors of primary and secondary education (Bessa et al., 2019; Hastie et al., 2011; Wallhead and O'Sullivan, 2005). In the sector of tertiary education, Sport Education could improve the physical, affective and cognitive domains of university students, which include aerobic fitness levels (Wahl-Alexander and Chomentowski, 2018), higher enjoyment (André and Hastie, 2017), social cohesion (Jenkins and Alderman, 2011), game performance and content knowledge (Layne and Yli-Piipari, 2015; Pritchard et al., 2019). However, we are still far from having a comprehensive knowledge of university physical education courses, especially in East Asian settings.

Consistent with the characteristics of Sport Education, the university physical education program in this study used a single sport within a given semester. Teachers

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could design longer lesson units with some particular aspirations like innovation and design, global citizenship, and social enterprise which may complement other subject disciplines and contexts. Students can enjoy not only the techniques and tactics of each sport, but also various outcomes through their assigned sport-related roles such as coaches, referees, statisticians, managers, journalists, and so forth (Siedentop et al., 2019). Sport Education is a way to engage students in the curriculum, teaching, and learning, and teachers could transfer responsibilities to students and let them cooperate and communicate within their teams through the activities and teaching materials (Durden-Myers et al., 2018).

While there is significant work on the successes of Sport Education, one area still needing attention is its ability to promote physical activity levels. Within this area, previous research has produced contrasting outcomes. Focusing on the amotivated students engaged in a 15-week basketball season, the Sport Education group elicited a higher level of MVPA than the traditional skill-drill-game group (Perlman, 2012). Parker and Curtner-Smith (2005) studied two preservice teachers who conducted a 10-week Sport Education football season as part of their co-teaching early field experience taken after a teaching methods course. However, the results from both studies indicated that the students did not attain the recommended moderate-to-vigorous physical activity (MVPA) levels. In contrast, students were active moderately and vigorously in 63.2% of lesson time in a 22-week floor hockey season (Hastie and Trost, 2002). Wahl-Alexander and Morehead (2017) also detected a higher MVPA percentage in Sport Education than traditional instruction when students participated in a residential summer camp. Two of these studies analyzed physical activity levels of children aged 9-12 years through the System for Observing Fitness Instruction Time (SOFIT; Parker and Curtner-Smith, 2005; Wahl-Alexander and Morehead, 2017). Similar to the studies investigating other pedagogies, the discussion over lesson content and teacher interaction in the context of physical education was neglected (McKenzie and Smith, 2017).

There is a lack of exploration regarding physical activity levels, lesson content, and teacher involvement in Sport Education, and how these variables connect with physical education and public health issues. As such, investigation on the association of these variables is warranted (McKenzie and Smith, 2017). Although the environmental barriers to promoting physical activities and fitness at schools have been examined in recent studies (Chow et al., 2009; Kwon et al., 2020; Liu et al., 2013; Smith et al., 2014; Sutherland et al., 2016; To et al., 2020), other streams focused on the arrangements of the lessons (Powell et al., 2019), revised policy (Lafleur et al., 2013; Mersh and Fairclough, 2010), and different pedagogies such as dynamic physical education (Stylianou et al., 2016) and tactical games models (Smith et al., 2015). Since roles and responsibilities are transferred to students in Sport Education, variables such as lesson content and teacher interaction tend not to be estimated. Accordingly, the purpose of this study is to examine how the variables of 'lesson content' and 'teacher interaction' in physical education lessons under Sport Education contribute to university students' physical activity levels.

Methods

Research design

This study was conducted at a university in Hong Kong which offers up to 163 required physical education courses each semester. A 12-hour continuing professional development workshop was organized for 25 physical education specialists who worked as university lecturers in June 2018 to introduce the concept of physical literacy and the issues of designing and implementing Sport Education. The coursework and lesson materials were then developed following the operationalization of physical literacy through Sport Education, including students' contracts for each role, lesson plans, coaching sheets, and score sheets. Eight courses of badminton, basketball, volleyball, handball, and woodball were randomly selected to adopt Sport Education during the second semester in the academic year of 2018-2019. Data of physical activity levels, lesson content, and teacher interaction in each lesson was collected through SOFIT. Prior to data collection, ethical approval was received from the Survey and Behavioral Research Ethics Committee of the Chinese University of Hong Kong (SBRE-19-018).

Participants

The demographic information of the physical education courses adapting Sport Education was obtained and is shown in Table 1. Six male and two female university lecturers with a mean age of 39.6 (±4.92) and with an average of 15.3 (±4.58) years of teaching experience took part in this study. 145 male and 57 female students aged 18.5 (±0.91) enrolled in the physical education courses.

These were all one-credit courses. 97% of the participants were Chinese. The remaining students were from other Southeast Asian countries. 153 students participated in team sports courses and the remaining were in those of individual sports. Written consent forms for study participation were obtained from physical education specialists and students.

Curriculum

In Hong Kong's educational policy, it is mandatory that physical education specialists deliver physical education lessons. Each single-sex course consisted of 13 weeks of a 90-minute lesson on a 1-day per week basis whereby the last three lessons were skills-based and knowledge assessments. According to the design of the course, the season followed a phased sequence of team selection, teacher-directed, pre-season, formal competition, and a culminating event in a progressive competition format. In the first two phases, teachers were responsible for conducting the lesson from the warm-ups, instruction of skills practices, and modified games. Students were assigned to consistent groups and sport-related roles at the end of the team selection phase. Subsequently, they gradually took on their specific responsibilities in the preseason phase through progressive activities of skills practice, modified games, and

Table 1. Characteristics of the required PE courses.

Sport	Lecturer	Class gender	Teacher gender	Venue	Class size (N)	Attendance (%)	Total lessons (N)	Class time (minutes)	
								Scheduled	Observed
Basketball	1	Male	Male	Indoor	26	85.8	10	90	82.6
	2	Male	Male	Indoor	26	89.0	10	90	94.6
Volleyball	3	Male	Male	Indoor	26	96.8	10	90	78.8
	4	Female	Female	Indoor	24	95.6	10	90	84.5
Handball	5	Male	Male	Outdoor	26	94.3	9*	90	94.8
	6	Female	Female	Indoor	25	91.6	10	90	87.5
Woodball	7	Mixed	Male	Outdoor	25	94.4	10	90	80.9
Badminton	8	Male	Male	Indoor	24	94.8	10	90	89.9

* One lesson was canceled because of the weather conditions.

competitions in each lesson to enjoy an authentic sports experience.

Data collection process

This study adopted SOFIT to investigate how lesson content and teacher behavior of university physical education curriculum implemented by Sport Education contributed to the physical activity levels of students. SOFIT is an objectively validated and comprehensive tool employing momentary time sampling through direct observation and recording systems for assessing physical education lessons and coaching settings. The lead author and a research assistant strictly followed the SOFIT description and procedures manual (McKenzie, 2015). Before data collection, they watched a 93-minute SOFIT Observer Training DVD to complete initial training of standardized classroom training, video analysis, and field practice. Subsequently, they reached an agreement on lesson content and teacher behavior, especially those which may have been difficult to categorize. To examine the reliability of data collection, they coded the lessons simultaneously in which only the data of the lead observer were used for analysis in the first two weeks of the courses. From the third week onwards, two observers randomly selected one course to be coded concurrently. All lessons were videotaped and all reliability scores during practice and data collection exceeded 80%. Students' arrival order was used to select for observation during each lesson. According to the protocol, the observers needed to select the 4th, 8th, 12th, 16th, and 20th students for lessons with less than 25 students, and the 5th, 10th, 15th, 20th, and 25th students for lessons with more than 25 students for observation. Each student was observed individually for each four-minute segment in a rotation sequence throughout the lessons. The last student was reserved for situations where an observed student left the recording venue.

The data of each outcome and process variable were collected by an interval coding system every 20 seconds (10 seconds observe and 10 seconds record) throughout the lessons. Physical activity levels were categorized as lying down, sitting, standing, walking, and vigorous. The codes of lesson content contained general content (transition, management, and break), knowledge content (physical fitness, general knowledge, rules, strategy, social behavior, and technique), and motor content (fitness, skill practices, gameplay, and other). The codes of teacher interactions consisted of promoting in-class, out-of-class, and does not promote any physical activity, fitness, or motor skills. The codes of teacher involvement were comprised of promoting fitness, demonstrating fitness, instructing generally, managing, observing, and doing other tasks. All data were recorded on the SOFIT recording form and summary form manually, entered in the electronic database system and cross-checked to maintain data quality.

Statistical analysis

All statistical analyses were performed using IMB SPSS 26. Descriptive data of mean, median, mode, range, and outlier tests were computed to inspect for any potential entry error. Demographic information about sports, class gender, teacher gender, venue, and phase was dichotomized as individual and team sports, mixed- and single-gender classes, female and male teachers, outdoor and indoor classes as well as before and after teacher-directed phases. The categories of walking and vigorous were added to give the score for MVPA levels. Physical activity level, lesson content, and teacher behavior were measured as a percentage of physical education lesson time. The skewness and kurtosis values of each data within the range of ±2 were analyzed (Field, 2017).

Independent samples t-tests were used to evaluate if there were differences in each variable of physical activity levels, lesson content, and teacher involvement between demographic information of the courses. Pearson's product-moment correlation was used to compute if there was any relationship between the measured variables. Regression analysis is a more robust statistical approach to employ than the bivariate analysis in a cross-sectional design study. Correspondingly, hierarchical linear regression analyses were used to compute how each variable of lesson content and teacher behavior predicted corresponding levels of physical activity. Demographic variables were entered at stage one of the regressions to determine if there was statistical significance in the independent variable. Consistent with the decision sequence in data collection, the variables of lesson content were entered at stage two while those of teacher behavior were entered at stage three. A significance level was set at 0.05.

Results

Considering the normality, the variables were excluded if the skewness and kurtosis values exceeded the range of ±2. Descriptive percentages of remaining variables with the consideration of each demographic information for further analyses were displayed in Table 2. Independent-samples t-tests were conducted and significant differences ($p < 0.05$)

were found in the variables of physical activity levels, lesson content, and teacher involvement between each demographic characteristic. There were dissimilarities between the individual and team sports in sitting and standing physical activity levels and general lesson content. For class gender, discrepancies were identified between mixed- and single-sex classes in all physical activity levels and when the teachers were managing the class. Sitting and MVPA levels, knowledge lesson content, and teacher observation were different between teacher genders. When comparing the venue of the class, there were contrasts in all physical activity levels, skills practices, and the level of teacher involvement. Comparing earlier and later phases of the Sport Education season, disparities were present where the lessons involved knowledge and gameplay content, and teachers' observation.

Table 2. **Descriptive results of means (standard deviations) for the PE class sample.**

		Sports			Class gender			Teacher gender			Venue			Phase		
Item	**Total**	**Individual**	**Team**	**t**	**Mixed**	**Single-sex**	**t**	**Female**	**Male**	**t**	**Indoor**	**Outdoor**	**t**	**Pre**	**Post**	**t**
N (%)	79	20 (25.3)	59 (74.7)		10 (12.7)	69 (87.3)		20 (25.3)	59 (74.7)		19 (24.1)	60 (75.9)		32 (40.5)	47 (59.5)	
Physical Activity levels (%)																
Sitting	12.35 (11.46)	4.1 (7.18)	15.14 (11.33)	-4.08***	0.76 (2.41)	14.03 (11.29)	-3.69***	19.9 (12.39)	9.79 (10.01)	3.67***	1.65 (2.69)	15.74 (11.09)	-5.47***	12.93 (13.14)	11.95 (10.3)	0.37
Standing	48.77 (23.28)	63.63 (24.76)	43.74 (20.64)	3.54**	86.01 (7.01)	43.38 (19.54)	6.81***	52.82 (16.55)	47.4 (25.13)	0.9	75.13 (14.13)	40.43 (19)	7.33***	47.17 (22.72)	49.87 (23.84)	-0.5
MVPA	38.77 (18.78)	32.23 (20.98)	40.99 (17.62)	-1.83	13.16 (6.79)	42.48 (16.97)	-5.38***	27.28 (9.97)	42.67 (19.51)	-3.37**	23.19 (13.1)	43.71 (17.63)	-4.67***	39.83 (19.71)	38.05 (18.3)	0.41
Lesson content (%)																
General	18.62 (8.8)	15.18 (9.46)	19.79 (8.33)	-2.07*	16.57 (10.19)	18.92 (8.63)	-0.79	19.27 (9.74)	18.4 (8.54)	0.38	20.53 (8.61)	18.02 (8.84)	1.09	19.01 (7.8)	18.36 (9.49)	0.32
Knowledge	16.93 (10.62)	15.25 (10.63)	17.49 (10.64)	-0.82	10.94 (11.39)	17.79 (10.3)	-1.94	21.35 (11.78)	15.43 (9.86)	2.21*	15.04 (11.28)	17.52 (10.43)	-0.89	22.15 (10.19)	13.37 (9.45)	3.93***
Skill practices	34.37 (15.79)	36.53 (14.7)	33.64 (16.19)	0.71	33.14 (17.31)	34.55 (15.68)	-0.26	32.99 (15.98)	34.84 (15.83)	-0.45	27.67 (15.44)	36.49 (15.42)	-2.17*	33.09 (14.22)	35.24 (16.86)	-0.59
Game play	19.1 (14.6)	20.14 (13.14)	18.75 (15.15)	0.37	19.88 (16.75)	18.99 (14.4)	0.18	14.74 (14.74)	20.58 (14.38)	-1.56	20.79 (14.16)	18.56 (14.81)	0.58	13.69 (11.98)	22.79 (15.18)	-2.84**
Teacher involvement (%)																
Instructs generally	38.57 (16)	42.48 (17.4)	37.25 (15.43)	1.27	32.82 (16.21)	39.41 (15.91)	-1.22	42.38 (16.41)	37.28 (15.79)	1.24	33.12 (13)	40.3 (16.56)	-1.73	41.11 (14.36)	36.84 (16.96)	1.17
Manages	26.3 (12.21)	27.62 (15.39)	25.86 (11.05)	0.56	35.12 (14.83)	25.03 (11.35)	2.53*	27.36 (12.98)	25.94 (12.03)	0.45	33.57 (11.85)	24 (11.48)	3.14**	24.5 (11.22)	27.53 (12.81)	-1.08
Observes	31.71 (14.18)	27.63 (13.34)	33.09 (14.29)	-1.5	31.54 (17.84)	31.73 (13.73)	-0.04	24.35 (10.72)	34.2 (14.41)	-2.8**	31.4 (13.77)	31.8 (14.42)	-0.11	27.19 (11.48)	34.78 (15.1)	-2.41*
Observed class time (minutes)	86.61 (18.9)															
Class size (N)	25.24 (0.84)															
Attendance (%)	92.78 (5.71)															

***p < .001; **p < .01; *p < .05 (two-tailed).

Table 3. Correlation of physical activity levels, lesson content, and teacher involvement (N = 79).

Variables		1	2	3	4	5	6	7	8	9
Physical activity levels	1. Sitting	-								
	2. Standing	-.60**								
	3. MVPA	.14	-.87**							
Lesson content	4. General	.11	-.04	-.02						
	5. Knowledge	.25*	-.10	-.03	-.16					
	6. Skill practices	-.11	-.03	-.10	-.17	-.10				
	7. Gameplay	-.05	-.17	.24*	.06	-.25*	-.56**			
Teacher involvement	8. Instructs generally	.14	-.25*	.23*	-.44**	.68**	.13	-.04		
	9. Manages	-.05	.26*	-.29*	.59**	-.25*	-.33**	.16	-.44**	
	10. Observes	-.22	.05	.06	.15	-.54**	.32**	.07	-.62**	-.12

** p < 0.01; * p < 0.05 (two-tailed).

Table 3 illustrated the correlation matrix between the variables of physical activity levels, lesson content, and teacher involvement. Considering the inter-relationships, standing physical activity levels were negatively correlated with sitting (r = -0.60) and moderate-to-vigorous (r = -0.87). The lesson content of gameplay indicated negative correlations with knowledge (r = -0.25) and skill practices (r = -0.56). Instruction was in negative correlations with management (r = -0.44) and observation (r = -0.62) of teacher involvement. Regarding the intra-relationship between physical activity levels with lesson content and teacher involvement, sitting physical activity levels (r = 0.25) and MVPA (r = 0.24) were positively correlated with knowledge and gameplay lesson content correspondingly. Teacher involvement in instruction was negatively correlated with standing physical activity levels (r = -0.25) but positively correlated with MVPA (r = 0.23). Teacher management was positively correlated with standing physical activity levels (r = 0.26) and but negatively correlated with MVPA (r = -0.29). General lesson content was negatively correlated with instruction (r = -0.44) but positively correlated with management (r = 0.59). Knowledge lesson content was positively correlated with instruction (r = 0.68) but negatively correlated with management (r = -0.25) and observation (r = -0.54). Skill practice was negatively correlated with management (r = -0.33) but positively correlated with observation (r = 0.32).

Table 4 demonstrated the hierarchical linear regressions of physical activity levels which were predicted by each variable of lesson content and teacher involvement. Controlling for the demographic data, the variables of lesson content were significant predictors of each physical activity level: sitting, $F(11, 67) = 9.31$, $p < 0.001$, adjusted $R^2 = 0.54$; standing, $F(11, 67) = 20.1$, $p < 0.001$, adjusted $R^2 = 0.73$; MVPA: $F(11, 67) = 18.43$, $p < 0.001$, adjusted $R^2 = 0.71$. The lesson content of general ($\beta = 0.29$), knowledge ($\beta = .29$) and skill practices ($\beta = -0.25$) predicted a significant variance in sitting physical activity levels. General ($\beta = -0.25$), knowledge ($\beta = -0.16$) and gameplay ($\beta = -0.25$) lesson content were the negative predictors of standing physical activity levels. Skill practices ($\beta = 0.25$) and gameplay ($\beta = 0.38$) predicted an increase in MVPA. Controlling for the variables of demographic information and lesson content, the models of teacher involvement in predicting each physical activity level were significant: sitting, $F(14, 64) = 7.93$, $p < 0.001$, adjusted $R^2 = 0.55$; standing, $F(14, 64) = 19.8$, $p < 0.001$, adjusted $R^2 = 0.77$; MVPA: $F(14, 64) = 16.66$, $p < 0.001$, adjusted $R^2 = 0.74$. However, there was no significant change in the model of sitting physical activity levels, nor were there significant predictors for standing physical activity levels. Teacher instruction was the only significant predictor for MVPA ($\beta = 0.38$).

Discussion

Contemporary physical activity research in the educational context is concentrated at the school level, rather than in universities (Lynch and Sargent, 2020). This study supplemented relevant literature by implementing Sport Education in a university physical education and physical activity setting. Coherent to the suggestion made by McKenzie and Smith (2017), the current exploration utilized SOFIT to examine lesson content and teacher behavior in relation to the curriculum. Specifically, it investigated how the variables of lesson content and teacher behavior contributed to the physical activity levels of university students during the required physical education lessons. Study findings from the SOFIT data revealed that during lesson time, only 39% of students participated in MVPA, and weak intra-correlations were found between the variables. Contrarily, predictive effects were found from the attributes of lesson content and teacher involvement on different physical activity levels. Results may provide implications for the instruction and administration of future Sport Education applications within university physical education.

In this study, there are important factors influencing data collected during physical education lessons. These include the class characteristics (i.e. size, gender, time, and attendance), instructional goals, instructional content, and environmental conditions (McKenzie and Smith, 2017). The class size for university physical education courses was around 25 students, and they use at least one piece of equipment during lessons. The lesson goals of each class were consistent in the Sport Education curriculum. This contained the physical, affective, and cognitive domains of physical literacy (Hastie and Wallhead, 2015). As the coursework was designed collectively, the phases of all courses were indistinguishable. Nevertheless, the MVPA levels still varied when considering different independent variables, especially sports type and venue.

Table 4. Hierarchical linear regression for the physical activity levels in physical education lessons (N = 79).

Independent variables	Sitting			Standing			MVPA		
	B	SE B	β	B	SE B	β	B	SE B	β
Step 1: Demographic variables									
Sports	0.32	0.09	1.23***	-0.55	0.13	-1.04***	0.23	0.11	0.54*
Class gender	-0.19	0.07	-0.55**	0.08	0.1	0.11	0.11	0.08	0.20
Teacher gender	0.14	0.07	0.53*	-0.56	0.1	-1.04***	0.42	0.08	0.97***
Venue	0.14	0.03	0.51***	-0.28	0.05	0.52***	0.15	0.04	0.33**
Phase	-0.01	0.02	-0.06	0.01	0.03	0.03	0	0.03	0
Class size	-0.12	0.04	-0.86**	0.25	0.06	0.88***	-0.13	0.05	-0.57*
Attendance	0.09	0.19	0.04	0.76	0.3	0.19*	-0.87	0.24	-0.26**
R	.68			.83			.82		
Adjusted R^2	.41			.65			.64		
F	8.59***			21.91***			20.63***		
Step 2: Lesson content									
General	0.38	0.12	0.29**	-0.67	0.19	-0.25**	0.29	0.16	0.14
Knowledge	0.32	0.11	0.29**	-0.35	0.16	-0.16*	0.04	0.14	0.02
Skill practices	-0.18	0.08	-0.25*	-0.12	0.13	-0.08	0.3	0.11	0.25**
Game play	-0.08	0.09	-0.11	-0.4	0.14	-0.25**	0.49	0.11	0.38***
R	.78			.88			.87		
Adjusted R^2	.54			.73			.71		
F	9.31***			20.1***			18.43***		
ΔR2	.15			.08			.08		
ΔF	6.19***			6.05***			5.47**		
Step 3: Teacher involvement									
Instructs generally	-0.01	0.16	-0.02	-0.44	0.24	-0.31	0.45	0.2	0.38*
Manages	-0.02	0.13	-0.02	-0.09	0.19	-0.05	0.1	0.17	0.07
Observes	-0.22	0.15	-0.28	0.19	0.21	0.11	0.03	0.18	0.02
R	.8			.9			.89		
Adjusted R^2	.55			.77			.74		
F	7.93***			19.8***			16.66***		
ΔR^2	.03			.05			.03		
ΔF	1.74			5.11**			3.29*		

MVPA = moderate to vigorous physical activity; B = unstandardized coefficients beta; SE B = standard Error for the unstandardized coefficients; β = standardized coefficients beta; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

One of the handball lessons was canceled because of adverse weather, instead, the lecturer provided some knowledge and video contents, and students discussed team tactics. The size of the instructional space impacts students' activity levels. In team sports courses, students were provided a half-court for their activities, however, a full court was provided for groups in the badminton course. Generally, most of the courses were team sports and racket sports. These sports promote high MVPA. An exception is woodball - a modified sport that combines golf and croquet, and usually involves standing and walking throughout the session. To adjust the intensity, the first 15 minutes of woodball lessons were designated fitness sessions. In this context, badminton and woodball were categorized as individual sports but in indoor and outdoor venues respectively. Due to the nature of the sports, the badminton course typically presented higher MVPA levels than woodball. Since both sports were considered individual sports, the possibility of underestimating its percentage of activity levels cannot be ignored.

Quality physical education should be designed to maximize students' participation in MVPA for 50% of lesson time to enjoy health benefits and reduce chronic disease risks (Centers for Disease Control and Prevention, 2010). In this study, however, 12% and 49% of lesson time were indicated as sitting and standing physical activity respectively. This was predominantly contributed by general and knowledge content, especially the positive predictive effects of the period of sitting physical activity. Teachers should decrease the amount of time spent on classroom management by considering the features of Sport Education and incorporating these into lessons (Whitehead et al., 2018). Taking record keeping as an example. Teachers could use scores to motivate students to complete their tasks more efficiently during the pre-season phase (Siedentop et al., 2019). Transferring responsibilities is one of the key principles to nurture physical literacy (Durden-Myers et al., 2018). Although students may struggle at first, teachers could also encourage them to design some corporate goals and tasks after class. These methods may create a more dynamic lesson environment which may contribute to the increment of MVPA standard of 50% lesson time.

The remaining 39% lesson time of MVPA was positively predicted by the variance of skill practice and gameplay lesson content. Sport Education employs a progressive competition format from small-sided games, modified games to formal competition over phases. This format leads to a greater variance of gameplay than skill content during the lessons. Besides the conventional skill practice sessions, students could also develop their movements and group tactics in a more authentic but unpredictable setting (Pot et al., 2018). Further, teacher instruction is a predictor of MVPA when controlling other independent variables. Instruction during MVPA usually happens when students

receive feedback after finishing a single task but are still walking or jogging. Given the analytical method of hierarchical linear regression, unfortunately, this study could not investigate whether skill practice or gameplay occurred concurrently with teacher instruction. Purposefully, some methods to increase lesson MVPA should be discussed. The researchers organized a professional development workshop to promote Sport Education before redesigning and implementing the curriculum. On-site consultation could be provided when teachers are unfamiliar with the changing roles of teachers and students (Sum et al., 2020). Follow-up workshops should also be organized for teachers to share good practices and strategies for increasing MVPA during physical education lessons (Sum et al., 2018).

It is important to highlight the limitations of this study, especially for the benefit of future investigators. Only one university provided mandatory physical education, funded by the University Grant Committee of Hong Kong, and was thus selected for this study. Other universities provided optional physical activity courses. These were not included in this study. However, their statistics may homogenize the demographic characteristics of teacher- and student- participants. Accordingly, the findings of this study may not be generalized to other educational and recreational settings. Although SOFIT is a validated surveillance instrument, we cannot exclude any probabilities that lecturers and students may be disturbed throughout the courses. Since this study aimed to discover the predictors of physical activity levels, although we conducted a series of t-tests for the course phases, we gathered all lessons into hierarchical linear regression analyses given the small sample size. This may underrate the disparity across different phases from the teacher-directed phases to pre-season and formal competition. In addition, there was only one instrument to assess the physical activity levels of students during physical education lessons, and more data collection methods (e.g. accelerometer, pedometer, etc.) may provide supplementary sources for measuring and analyzing physical activity levels.

Since the UNESCO Quality Physical Education Guidelines only covered primary and secondary education (McLennan and Thompson, 2015), a lack of related information was provided for university programs. Future studies are thus warranted on various instructional models in researching physical activity levels during university physical education, especially in Sport Education. Prospective studies could contribute to whether there is concurrent pertinence between skill practice or gameplay content with teacher instruction. This may present more understanding of how teachers instruct in using a game-based instructional model. Furthermore, such analysis could extend to the comparison between each phase if there is a larger course sample size. Sport Education develops physical literacy (Pot et al., 2018), which is about an individual valuing and being responsible for lifelong physical activities. Researchers could investigate transforming physical activities from physical education to the recreational context through a longitudinal study design (Wang et al., 2020). Such guidelines for the university's physical education would be more influential with these robust analytical data.

Conclusion

This study designed and implemented Sport Education for the required physical education courses in the university context. SOFIT findings indicated that the students did not meet the MVPA recommendation of 50% lesson time. Many lessons were seen to be dominated by teachers' instruction and team discussion, which produced patterns of sitting and standing physical activities. Suggestions for utilizing the element of Sport Education were made. Take record-keeping as an example, teachers could give the team hustle points and role points when students completed the task in the shortest time and accomplished their responsibilities respectively. Remarkably, gameplay contributed to the lesson MVPA significantly in the university curriculum of Sport Education, given the synergy between gameplay content and teacher behavior is under-estimated. In conclusion, this study strengthened the Sport Education research in the following two dimensions – the university physical education context and the data collection and analysis through SOFIT.

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Key points

- This pioneering study used SOFIT to investigate the physical activity levels of students at a university where Sport Education was implemented.
- Results indicated the student-participants did not meet the MVPA recommendation of PE lessons and this situation may have been contributed by time spent in knowledge acquisition and general content.
- Future research could focus on the relationship between gameplay content and teacher behaviors, and the application of objective measures such as accelerometers and pedometers.

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