

**Title: Effect of Sport Education in University Required PE on Students'
Perceived Physical Literacy and Physical Activity Level**

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Study Protocol

Research design

This study employed a 10-lesson cluster-randomized study design to examine the effect of sport education on domains of student PL and physical activity levels. Questionnaires, accelerometers, and video recordings of PE lessons were used to collect self-report and objective data measures.

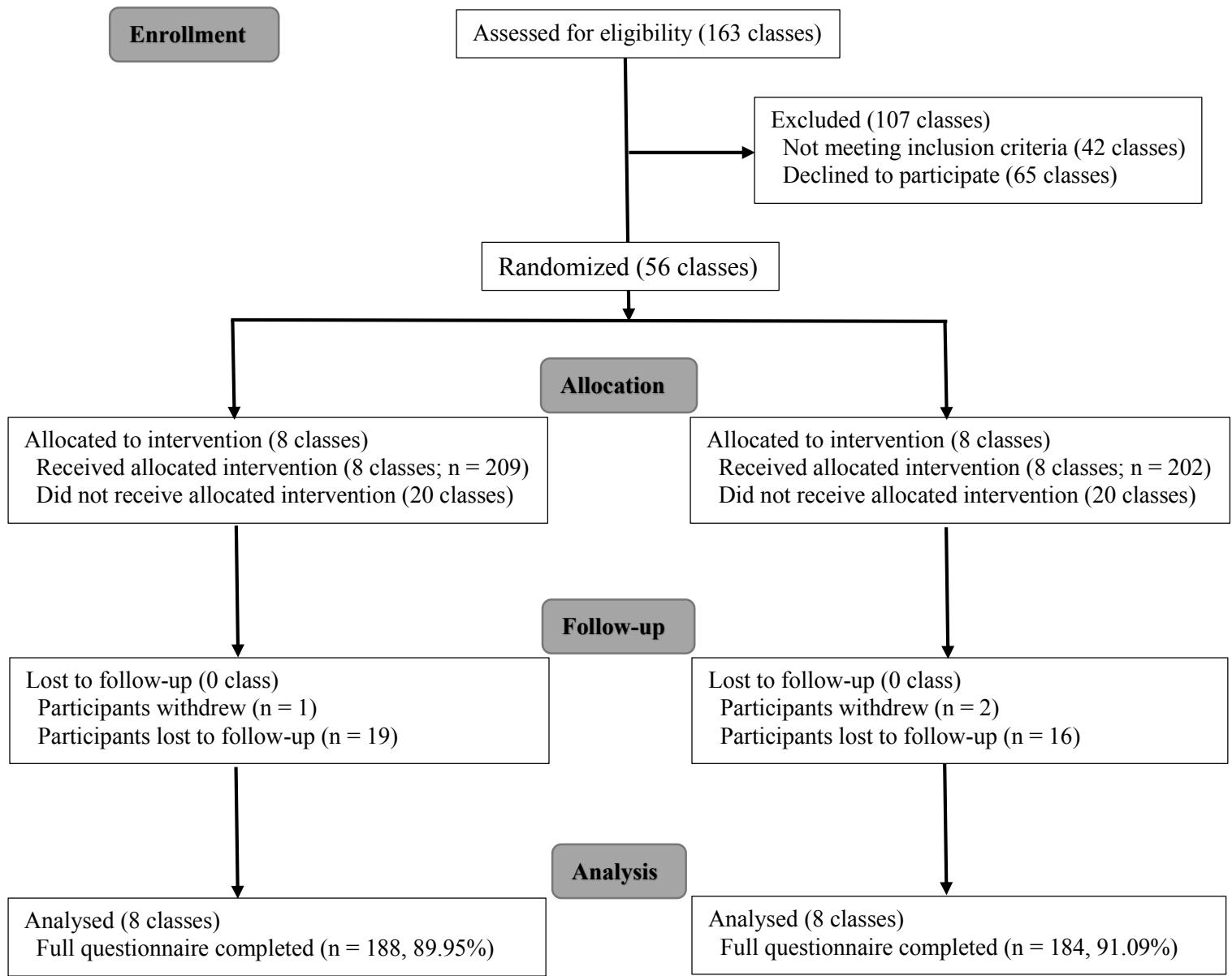
Eligibility and randomization

Only one university in Hong Kong fully funded by the University Grants Committee and requires the completion of two semesters of PE coursework for graduation. Lecturers in the PE program are required to have a master's degree or above and have more than 5 years of teaching experience. All lecturers attended a 12-h continuous professional development workshop on sport education. Of the 25 lecturers who attended the workshop, 11 of them consented to participate in the study. The required sample size of students was calculated based on the hypothesized effect sizes and the likely rates of participants dropout for outcome measures. A total number of 2886 students were admitted to the university in the academic year, with an estimated required cluster sample size of 341 with an effect size of 0.25, α of 0.05, and a power of 0.95 (Faul et al. 2007). In anticipation of 10–20% of the dropout rate across data collection phases, this led to a required number of 8 classes for each of the sport education and traditional groups. PE classes were initially grouped by lecturers and types of sports (individual sports, team sports, and physical conditioning) and then randomly assigned to each intervention (Fig. 1) by a computer-generated sequence (GraphPad Software, Inc.) conducted by a statistician who was blind to the purposes of the study. The demographic background and corresponding courses for each of the eight lecturers are shown in Table 1. Students were eligible to participate in the study if they were aged 18 or above and indicated all negative statements in the self-screening Physical Activity Readiness Questionnaire (Thomas et al. 1992) which can uncover heart, circulatory, balance, medication, emotional, and joint problems that could make exercise difficult or dangerous for some people. Written consent for study participation was also obtained.

PE curriculum intervention

The goals of the required PE courses are to encourage students to participate in lifelong physical activities by developing their skills and fitness, motivation, knowledge, social, and sportsmanship. These domains of learning connect to the holistic attributes of PL; however, this term is not explicitly mentioned in course objectives or used to design curricular materials. PE teachers in Hong Kong generally adopt a teacher-directed approach in delivering content and accomplishing the objective of the curriculum (Ha 2016). The implementation of sport education was an attempt to infuse a more student-centered instructional model that has been empirically validated to elicit positive changes in student PL (Farias et al. 2020). The sport education professional development workshop focused on the development of a season structure, the changing roles of teachers and students, the assessment of personal and social responsibility, and the application of related pedagogical methods. Following the instructor workshop, two meetings were held with the PE lecturers to discuss the design of specific coursework and class materials. Sport education seasons were designed for badminton, basketball, handball, physical conditioning, swimming, woodball, and volleyball. Each sport education season included ten 90-min lessons, 1-day per week with each season following the five-phase sequence of team

Figure 3.1. Participant Flow of Enrolment and Allocation in the Trial.



selection, teacher-directed, preseason, formal competition, and a culminating event (Hastie et al. 2014). Participants in each class were divided into teams for the duration of each season and assigned specific sport-related roles (e.g., coach, fitness trainer, equipment manager) at the end of the team selection phase. Students gradually increased their responsibility for learning and had equal opportunity to participate in every lesson with tasks progressing from drills to modified games and competitions to obtain more authentic sports experiences within the lessons. To evaluate model fidelity, a sample lesson from each phase of the sport education season was observed and coded by the primary researcher using the sport education benchmark observational instrument (Ko et al. 2006; Sinehnikov 2009). Fidelity analysis revealed 100% compliance with season, affiliation, formal competition, and culminating event benchmarks.

Participants within the control group classes attended PE classes where teachers used traditional teacher-directed methods to teach the specific activities. These lessons started with a teacher-directed warm-up routine, followed by direct instruction of skills practices, and games without a consistent team and modification to meet the objective of the courses. Within the direct teaching approach, the teacher was assigned responsibility for all task presentation components of the learning tasks. No student role responsibilities or student-directed tasks were included within this approach. Students within the intact class changed teams each lesson and scores were not formally recorded for the game outcomes. Analysis with the sport education benchmark observational instrument revealed none of the instructional behaviors associated with the key features of the model.

Data collection protocol

During the first week of the semester, a baseline questionnaire was distributed by the researchers and lecturers to all participants to obtain students' self-reported information including perceived PL, physical activity levels, and perceptions of motivational climate in PE classes. Demographic information is related to participants' age, gender, ethnicity, undergraduate program and year of study, and years of sport participation. PL is both an antecedent and consequence of physical activity (Edwards et al. 2017) and represents the lived experience of the PL journey of an individual (Sum et al. 2018a). A primary outcome measure was the participants' self-reported and objective physical activity levels. As there may be an over-reporting of the self-report physical activity levels, a subsample of 64 randomly selected student participants per intervention group also collected objective physical activity levels using accelerometers. Accelerometers were worn for at least 8 h per day in seven consecutive days during the first week of the semester. During the intervention, all lessons were videotaped and coded using the System for Observing Fitness Instruction (SOFIT) which elicits percentage of PE time at different intensities of physical activity, lesson context, and teacher involvement in PE lessons. Participants recompleted the questionnaire, and the subsample wore the accelerometers during the post-intervention phase (the 10th lesson at 11th week of semester) and the follow-up phase (15th week of semester).

Physical activity measures The globally standardized and validated short version of the International Physical Activity Questionnaire was used to measure self-report physical activity levels (Craig et al. 2003; Hallal et al. 2012). Four generic items of vigorous, moderate, walking, and sitting were included to obtain the physical activity levels from the participants. Example item included the following: During the last 7 days, on how many days did you do vigorous physical activity like heavy lifting, digging, aerobics, or fast cycling (vigorous)? The total

duration of different intensities of physical activity which occurred for at least 10 uninterrupted minutes in the last 7 days was used for calculations (Booth 2000).

Accelerometers (Actigraph wGT3X+) were used to measure the objective physical activity levels (light, moderate, and vigorous) of participants, and physical activity intensity was calculated as a metabolic value (Evenson et al. 2008). The dynamic range of accelerometers is \pm 6MET with 3 axes and 3 mg/LSB of sensitivity. Only data that recorded more than 8 h per day and 5 days per week were used for analysis.

SOFIT is a validated and reliable momentary time sampling and interval observation instrument to gather quantitative data for assessing physical activity during PE lessons (McKenzie et al. 1992). SOFIT includes three intensities of students' physical activity levels (lying down, sitting, standing, walking, vigorous), lesson context (general, knowledge, fitness, skill practice, game play, free time), and teacher behavior (promotes fitness, demonstrates fitness, instructs generally, manages, observes, or other task) or teacher interactions (promoting "in-class" or "out-of-class" physical activity). Each category is coded using interval coding every 20 s (10 s observe; 10 s record) throughout the lesson. The observer decides on what is occurring at the moment an observation interval ends.

Situational motivation scale (SIMS) The SIMS is a 16-item instrument that was used to measure participants' situational intrinsic and extrinsic motivation while performing given physical activities. The four behavioral subscales include intrinsic motivation, identified regulation, external regulation, and amotivation (Deci et al. 1991). Participants responded to the instrument on a 7-point Likert scale (1 = not at all true and 7 = very true). Example items include the following: (a) this activity is fun (intrinsic motivation); (b) I believe this activity is important for me (identified regulation); (c) I do not 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). Guay et al. (2000) reported adequate internal consistency ($\alpha = 0.77$ – 0.95) and construct validity in physical activity settings among college-aged students.

Physical activity enjoyment scale (PACES) PACES is a survey instrument that measures how much a student enjoys participating in physical activity. Participants responded to the 16-item instrument on a 5-point Likert scale (1 = disagree a lot and 5 = agree a lot). There are nine positive items such as "I find it pleasurable" and "It gives me energy" and seven negative items 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. Motl et al. (2001) established adequate internal consistency ($\alpha = 0.81$ – 0.86) and factorial and construct validity of PACES with college-aged students.

Perceived physical literacy instrument (PPLI) The PPLI is a 9-item instrument that has been used to measure the perceived PL of teachers (Sum et al. 2016; Sum et al. 2018b), adolescents (Choi et al. 2018; Sum et al. 2018a), and coaches (Li et al. 2019). Three subscales within the instrument assess the PL attributes of "sense of self and self-confidence," "self-expression and communication with others," and "knowledge and understanding" (Whitehead 2010). Participants responded to the instrument on a 1 to 5 Likert scale (1 = strongly disagree and 5 = strongly agree). Example statements include the following: (a) I am physically fit, in accordance with my age (sense of self and self-confidence); (b) I have strong social skills (self-expression and communication with others); and (c) I am aware of the benefits of sports-related to health (knowledge and understanding). The scale scores are reliable with the internal consistency from 0.73 to 0.76 (Sum et al. 2016).

Empowering and disempowering motivational climate questionnaire in PE

(EDMCQ-PE) The EDMCQ-PE is a 34-item instrument based on achievement goal theory and self-determination theory to assess students' perceptions of empowering and disempowering features of the motivational climate created by their PE teachers. Participants responded to the instrument on a 1 to 5 Likert scale (1 = strongly disagree and 5 = strongly agree). Example statements include the following: (a) My teacher gave pupils choices and options (empowering) and (b) My teacher tried to interfere in aspects of pupils' lives outside of PE (disempowering). Milton et al. (2018) provided evidence of the EDMC-Q as internally consistent ($\alpha = 0.82-0.91$) and has factorial and construct validity.

Pilot study

A pilot study was conducted to ensure that the randomized controlled trial was scientifically valid (Lancaster et al. 2004). A convenience sample of 55 full-time undergraduate students was recruited to obtain their feedback on the data collection procedure and the comprehension of the questionnaire. Participants' ethnicity, studying program, and the year of study were added into the revised questionnaire which was also reviewed and considered to be content valid by experts in this area of research.

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