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 (β = 0.29), knowledge (β = .29) and skill practices (β = -0.25) predicted a significant variance in sitting physical activity levels. General (β = -0.25), knowledge (β = -0.16) and gameplay (β = -0.25) lesson content were the negative predictors of standing physical activity levels. Skill practices (β = 0.25) and gameplay (β = 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 (β = 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.

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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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